THE
ENGINEERING MAGAZINE
THE WORLD IS ITS FIELD

VOL. XXXVI. FEBRUARY, 1909. No. 5.

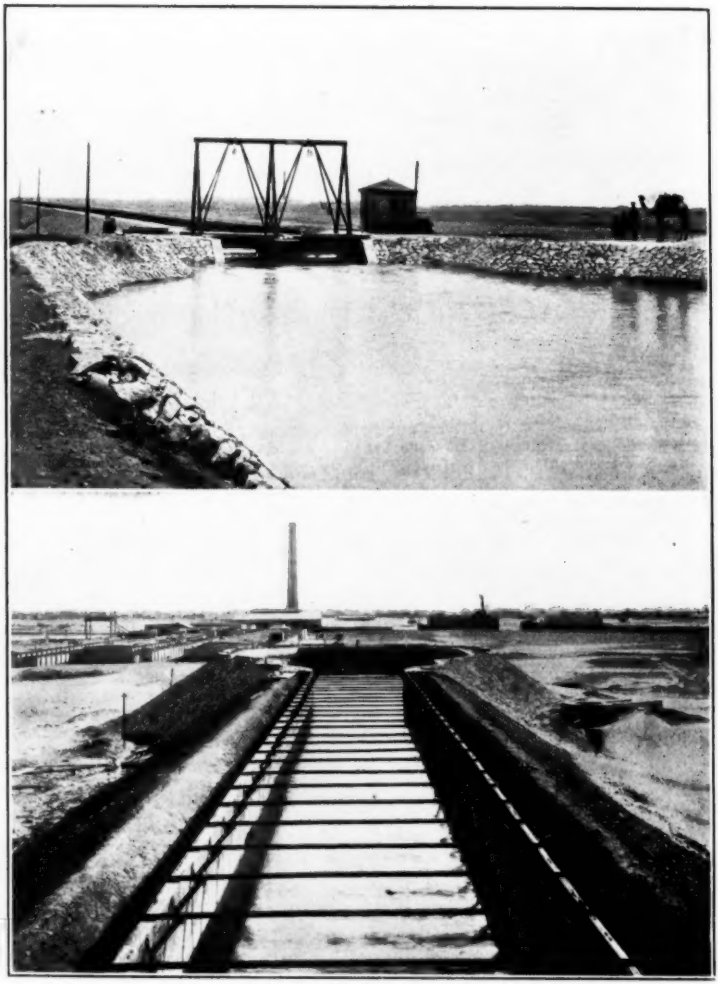
MECHANICAL IRRIGATION STATIONS ON THE NILE.

By J. B. Van Brussel.

The work described in the following pages is interesting on account of its location and the circumstances surrounding the construction, on account of its effect in restoring to fertility and production a long barren region of the globe, and on account of the confident use made of machinery to solve difficulties imposed by the natural topography of the land.—THE EDITORS.

EGYPT has been known as one of the most fertile countries in the world, its large fertility being dependent upon the Nile. This river, during its annual floods, not only supplies the necessary moisture to the ground, but by its deposited silt furnishes an excellent fertilizer. The soil which is not within the area of the annual floods is dry and parched, and is supposed to have received no water for the last 4,000 or 5,000 years. It is, moreover, saline, and for this reason it is necessary to wash the ground for from three to four weeks, before any crops can be grown upon it. Long before the beginning of the Christian era, the Egyptian cultivators endeavored to utilize the fertilizing power of the Nile on desert portions of the country, and large networks of canals and innumerable scoop-wheels worked by men or animals served this purpose. Serious improvements in the irrigation systems were not made for thousands of years, and it is only at the end of the nineteenth century and in the beginning of the twentieth that the problem of irrigation has been solved in a satisfactory way.

The centrifugal pump, which had long been treated more or less contemptuously, but which in the last few decades has been so carefully developed that today it successfully competes with the piston



SLUICE GATES, SERVICE RESERVOIR, AND PART OF THE STEEL CANAL, WADI KÔM-OMBO IRRIGATION SCHEME.

pump in many forms of service, has fulfilled admirably the requirements at the Nile. Apart from the fact that piston pumps are not well adapted to lift large quantities of water to small heights, the quality of the Nile water, with its large amount of silt, almost completely precludes the use of the piston pump, while the centrifugal pump is practically unaffected thereby.

One of the most important irrigation schemes carried out during recent years, and one of the most interesting from the engineering point, is that of Wadi Kôm-Ombo, in Upper Egypt; it utilizes a portion of the additional Nile water supply stored up by the Assuan Barrage. Kôm-Ombo is the site of an ancient town, and also of a famous temple, the ruins of which still exist. The irrigation estate, which covers nearly 150,000 acres, is bounded on the west by the Nile. The Egyptian State Railway's main line from Luxor to Assuân runs through the property, and to the eastward lies the desert.

The east bank of the Nile at Kôm-Ombo is too high to allow of the land being irrigated at flood time in the usual manner, and in order to obtain an adequate supply of water for the continual watering of this large tract of land, it was necessary to put down sets of powerful and specially designed pumps. These pumps lift the water through suction mains 2 metres in diameter, and discharge it into riveted steel rising mains 2 metres in diameter, which in their turn deliver the water into a service reservoir. A large steel canal starts from this service reservoir and delivers the water into distributing earth canals or culverts, from which it flows over the land.

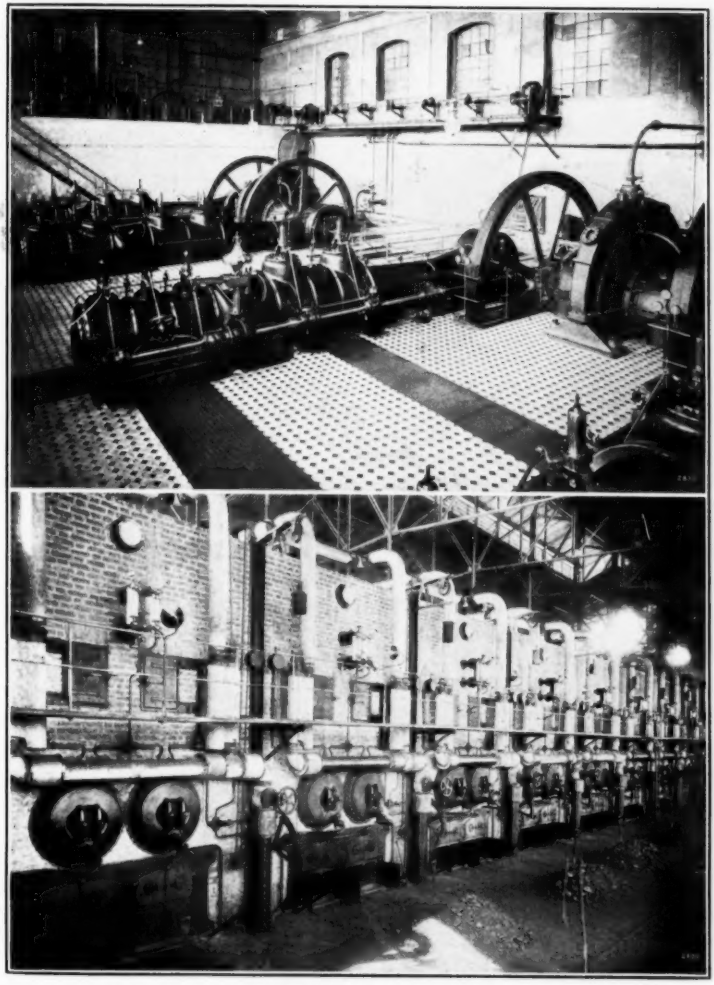
The pumps are placed as near to the Nile as the condition of the ground, which is often very bad, permitted. As the entire area to be irrigated is situated at such a level that even during the period of floods the water does not reach it, the pumping plants must operate continuously during the entire year. A breakdown in any one of the plants might result in the destruction of part of the crop. The first point to demand consideration was therefore absolute reliability of working. Another was to work with the lowest possible consumption of coal per unit of water lifted. The entire area is divided into three zones, 325 feet, 330 feet and 335 feet above sea level respectively, which are irrigated alternately. As the water level of the Nile varies about 23 feet to 26½ feet during the year, the pumps have naturally to work at variable heads.

The three pumping plants work under the same conditions. These working conditions are shown in the table on the following page:

Level of Nile.	I. Low	I. High	II. Low	II. High	III. Low	III. High
Manometric lift	10.4	12.0	20.9	13.5	22.4	15.0
Delivery in litres per second	3,000	3,000	3,000	3,000	3,000	3,000
Theoretical output in horse-power	776	480	838	540	895	600
Indicated output of the steam engine	1,195	860	1,290	950	1,355	1,000
Number of revolutions of engine	103	82	106	86	110	91
Cut-off in the high-pressure cylinder per cent	30	25	32	28	33	31
Coal consumption per 1,000 cubic metres of water lifted (kilogrammes)	55.0	40.0	59.5	44.0	68.0	47.0

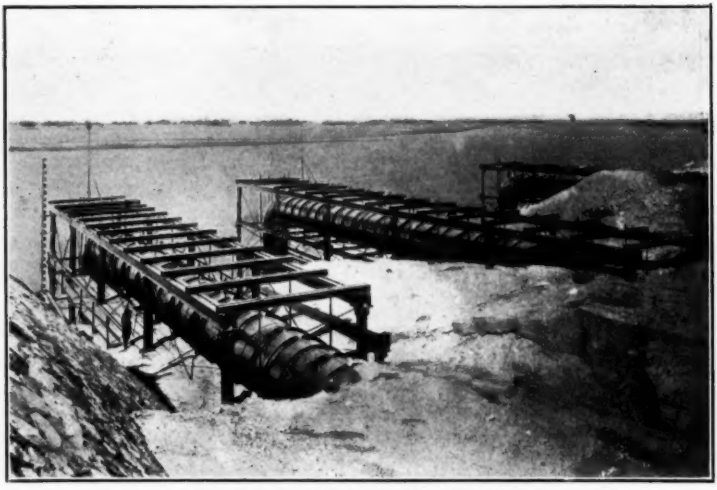
In the case of the first two plants the pumps, which were coupled direct to the steam engines, were placed 20 feet above the low-water line of the Nile. The entire engine room thus lies below the high-water level, and has therefore to stand great pressure, especially on the floor surface. The steam for both engines of these plants is generated by a plant of ten boilers. They have a heating surface of 2,152 square feet. A special arrangement of the grates was necessary, as during a part of the year the boilers are fed by waste material, such as straw, cotton-plant shrub, &c. Two grates had therefore to be provided, the top one of 35.5 square feet being used for coal firing. This can be removed so that the straw, shrubs, &c., can be burnt over a step grate below. The working boiler pressure is 185 pounds per square inch. On either side of the main drum superheater coils are arranged. In these the steam is raised to a temperature of 482 degrees F. The heating surface of each superheater is 376 square feet. Before entering the chimney the gases heat a Green economizer with 320 tubes provided with mechanical scrapers. These mechanical scrapers are run by two small steam engines. The thermal efficiency of the steam plant is increased by 5 per cent through the use of the economizer.

The steam engines are horizontal four-cylinder triple-expansion Sulzer valve-gear engines. The high-pressure cylinder with a diameter of 19⅝ inches and one low-pressure cylinder with a diameter of 34½ inches are arranged tandem on one side of the crank shaft, and the intermediate pressure cylinder of 34½ inches diameter on the other side, with the low-pressure cylinder, 34½ inches diameter, behind it. The cranks are set at an angle of 90 degrees, the common stroke being 51 inches. All cylinders are provided with steam jackets. Two fly-wheels of 18.7 feet diameter are arranged on one shaft. The machines are started by means of a steam barring gear. The condenser is arranged in the pit below the low-pressure cylinders.



ENGINE AND BOILER INSTALLATIONS OF THE FIRST TWO PUMPING PLANTS.

Horizontal four-cylinder triple-expansion engines, 19⅝, 34¼, 34½ and 34½ by 51 inches. Ten boilers, with double grates for burning waste, etc. Superheaters and economizers. Sulzer Bros., Winterthur.



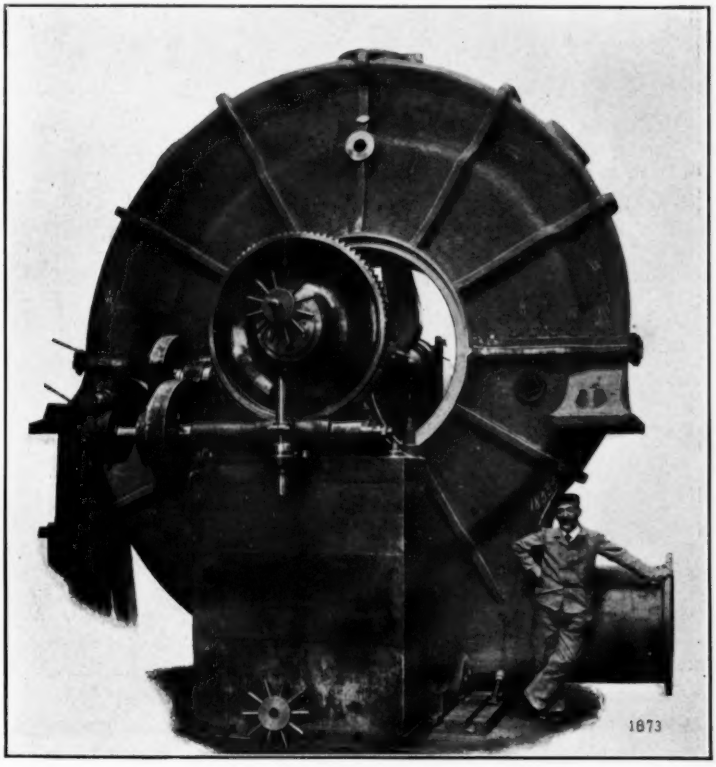
THE SUCTION PIPES AT THE RIVER NILE.

These condensers are driven from the crank pin of the engine. The injection water is taken from the suction pipe of the pump. The overflow from the condensers is led into two communicating reservoirs. A pipe dipping into one reservoir leads to the suction pipe of the pump, so that the overflow water from both reservoirs is drawn away. During high water, however, when the suction pipe also is under pressure, the overflow must be delivered into the large suction pipe of the pump against this pressure by means of a small centrifugal pump. The casings of the large centrifugal pumps are of spiral form. They are cast in two parts and provided with strengthening ribs. The diameter of each impeller is 10.7 feet.

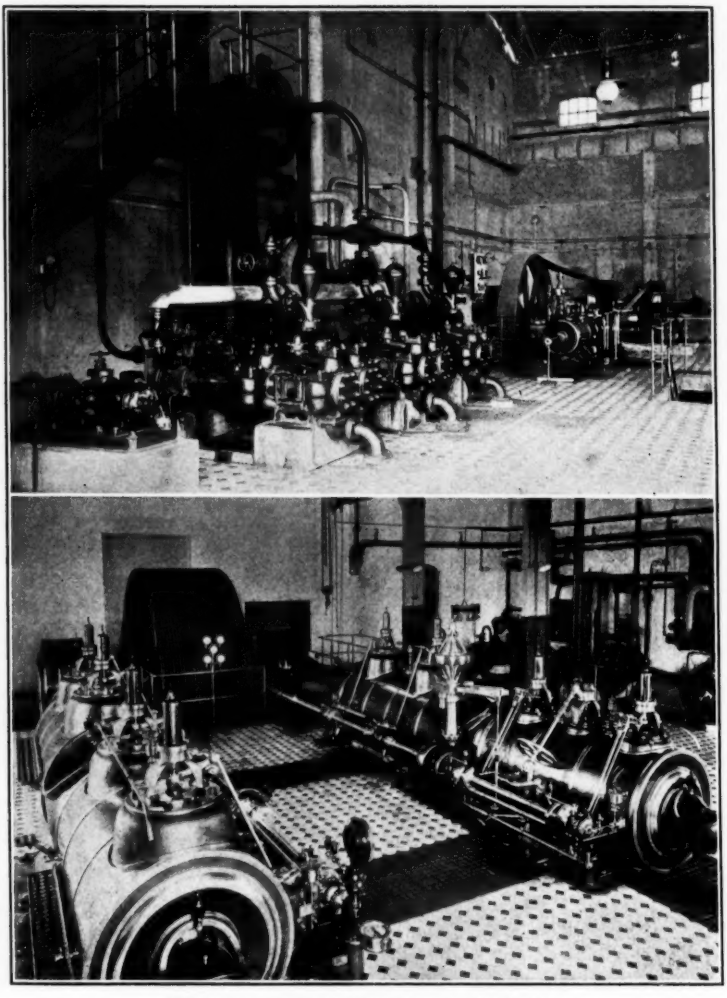
An independent suction pipe 302 feet in length and 78½ inches in diameter is provided for each of the centrifugal pumps. This pipe is carried on a heavy iron trestle over the bank of the river. The suction bell at the end of each suction pipe has an inside diameter of 118 inches. Each of these suction pipes enters into a large sheet iron distributing tank provided with an air chamber. From this the water is drawn through two suction pipes of 39⅜ inches diameter. After passing through the sluice valves, it enters both sides of the pump. The delivery opening of the pump is 31½ inches diameter, but the delivery pipe increases to a diameter of 78½ inches at the throttle valve. To exhaust the air from both the pumps as well as

from the suction piping, a steam vacuum pump is provided, with a piston of 4 inches diameter and a stroke of 12 inches. This pump runs at 160 revolutions per minute. The water draining from the stuffing-boxes of the centrifugal pump is led to small tanks, from which it is removed by ejectors.

The feed-water is taken from the Nile by a vertically driven high-lift centrifugal pump, and forced through two Reisert filters into a feed-water tank in the foundation of the engine-room pit. Two steam feed-pumps deliver the filtered water from the reservoir through the feed-water heater and economizer into the boilers. The feed-water heater receives the exhaust steam from the feed pump and vacuum pump.



ONE OF THE CENTRIFUGAL PUMPS.



PORTIONS OF THE MECHANICAL INSTALLATION.

Above, the feed pumps and lighting unit; below, the engine room of the third pumping plant.

In the main engine room there is also a small horizontal single-cylinder condensing slide-valve engine, with a cylinder of 9 inches and 21¼ inches stroke. It works with an initial steam pressure of 156 pounds per square inch and a speed of 130 revolutions per minute. A belt fly-wheel of 9.2 feet diameter transmits 55-60 horse power to a main shaft in the engine room. A continuous-current generator working at 230 volts running at 700 revolutions per minute and taking 30-35 horse power is driven from the main shaft. When the water is high this main countershaft also drives the pumps which deliver the overflow water from the main engines. The generator supplies current for lighting the entire plant, as well as for a motor in the adjoining building. This building contains a small ice-making plant and workshop, both driven from this motor, which, when running at 1,050 revolutions per minute at 230 volts, develops 25 horse power. The ice plant requires 4-5 horse power. The cooling water for the condensers is provided from the Nile by a small electrically driven centrifugal pump. An adjoining building contains a 35 horse-power Diesel engine as a spare, and this can drive the workshop independently of the boiler plant.

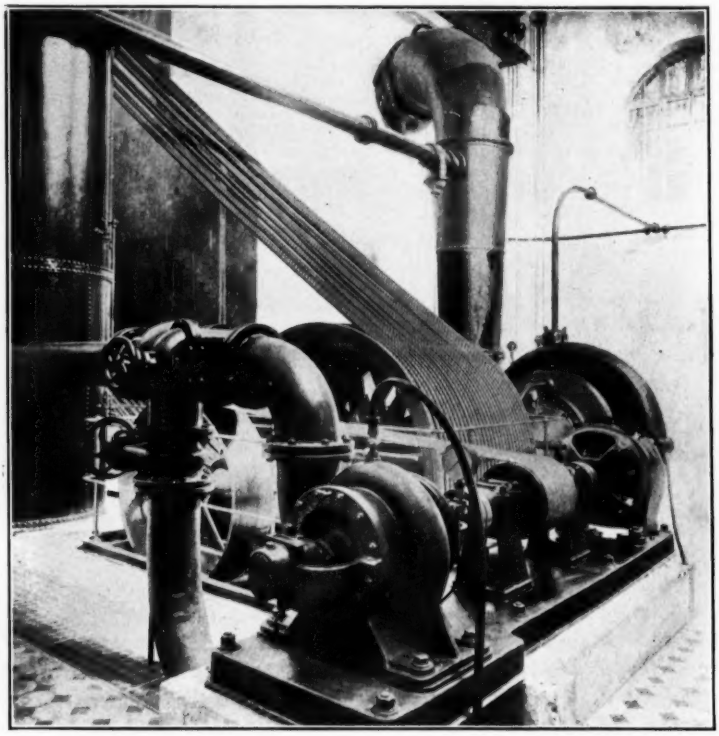
The many difficulties met with in building the engine-rooms of the first two plants were the cause of the buildings for the third plant being designed slightly differently. Such a simplification was possible by placing the steam engine above the reach of high water. The pump, on account of the suction lift, could not be placed higher. For this reason the advantage of direct coupling of pump and engine had to be abandoned and rope drive adopted.

The boiler room contains four water-tube boilers. The main drum has a length of 24.6 feet and a diameter of 4.3 feet. Together with the 129 water tubes of ⅞ inch outer diameter and 15.7 feet length, and with the headers, the total heating surface of each boiler is 2,152 square feet. Between the main drum and the tubes a superheater with 752 square feet of heating surface is provided. The arrangement of the grates is the same as that in the first two plants.

As there would have been difficulties, on account of the bad soil, in building a brick chimney, one of sheet iron only 99 feet high, with artificial draught, has been provided. The combustion gases first pass through a Green economizer having 400 tubes, and from there they are drawn by an electrically driven fan into the chimney. A second fan serves as spare. One fan is capable of delivering about 212 cubic feet of gases per second, giving a vacuum of ¾ inch to 1.2

inches water column when running at 275 revolutions per minute. The power required for one fan is 4 horse power.

The same type of engine as in the first two plants has been adopted, viz., a four-cylinder triple-expansion engine with Sulzer valve gear. A rope fly-wheel with thirty ropes drives the pump. The diameter of the impeller of the pump is 78½ inches, the design of the pump being otherwise the same as that of the other two pumps. At one end of the pump shaft of the delivery pump is mounted a belt pulley driving a centrifugal pump and a small dynamo. The pump and dynamo are erected on a common base-plate, and their shafts are coupled together. The pump sucks water from the main suction pipe, and delivers it into a reservoir, from which the condensers of the main engine draw the water. At times of flood, when the suction



AUXILIARY PUMP AND DYNAMO AT THE THIRD PUMPING PLANT.

pipe is under pressure, this small pump is not needed for the water then flows of its own accord through a by-pass around the small pump into the injection reservoir. In case through any cause the small pump is stopped, the injection reservoir can also be filled from the large delivery pipe, but this method will only be resorted to in case of emergency as loss of pressure is caused.

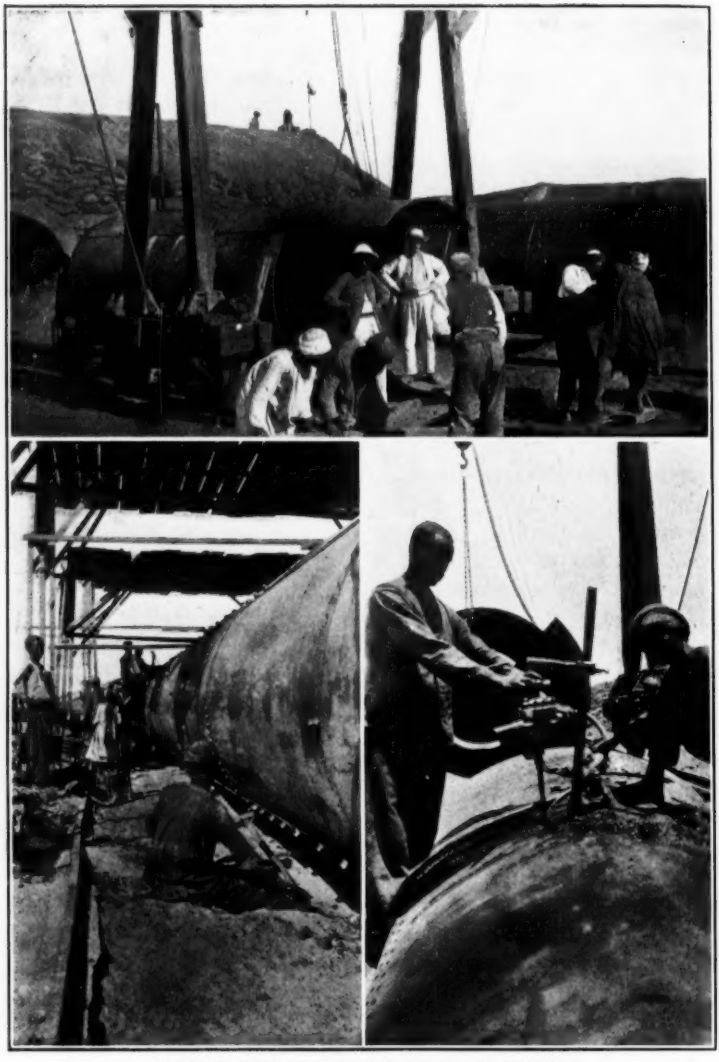
The feed water which is taken from the large delivery pipe is led through the filters and then flows into the feed-water tank. Two electrically-driven high-lift centrifugal pumps force it through two filters to make it clean. Part of this purified water is used for cooling purposes, the remainder flowing through a float valve into a second tank. From this two steam pumps take the water and force it through the feed-water heater, a water meter, and then through the economizer to the boilers. The feed-water heater gets its steam from the exhaust of the steam pumps and from the vacuum pump, which is used to exhaust the air from the large centrifugal pumps and piping. The exhaust steam of a small vertical piston-valve engine can also be used for heating. This engine, which works non-condensing, has a cylinder diameter of 7½ inches, a stroke of 8 inches, and develops 30 horse power when running at 325 revolutions per minute. It is coupled direct to a continuous-current dynamo working at 230 volts, and having an output of 20 kilowatts. This dynamo supplies current for lighting and for fan motors. The dynamo previously referred to supplies current to the motors for the centrifugal feed pumps.

The engine room is provided with a traveling crane of 38-feet span and 9-tons capacity, while the pump chamber is served with a smaller crane of 28-feet span and 6-tons capacity.

The machinery was all supplied and erected by Messrs. Sulzer Bros., Winterthur.

Two rising mains, each 2 metres in inside diameter, are taken away from the pumping stations to a basin distant 460 feet, and situated at a level of 350 feet. This basin or service reservoir is made of reinforced concrete. The plates of the raising mains are 9 millimetres thick and are riveted together with ¾ inch panhead rivets. The mains are made with four plates to the circumference, the circumferential seams breaking joint.

The steel canal which starts from the service reservoir has a total length of over 5,200 feet. It is nearly semicircular and composed of riveted steel, the plates being 6 millimetres thick. The diameter of



CONSTRUCTION OF THE 2-METRE RISING MAINS.

Above, plating at the reservoir end. Below, on the left, riveting; on the right, pneumatic drilling.

this canal is 20 feet, its depth nearly 12 feet. It is built up of seven plates round the circumference, the plates being connected together by ½-inch snaphead rivets.

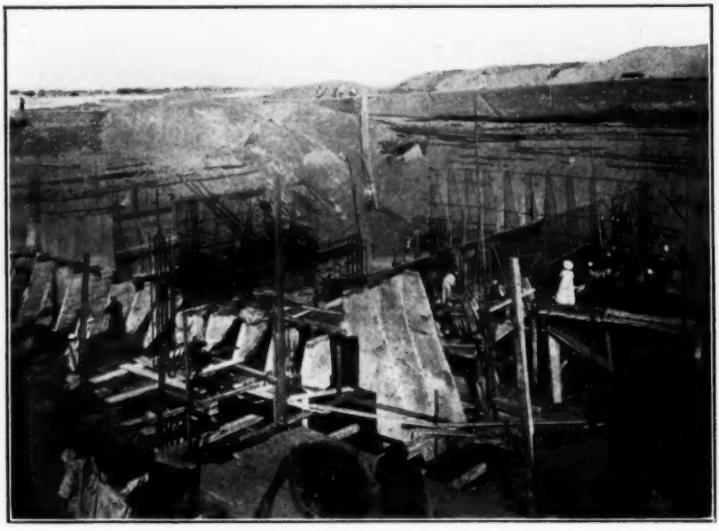
The circumferential seams break joint. External F-iron stiffeners, 5 inches by 3 inches by ⅜ inch, are riveted on at 2 feet 6 inch centres. There is also a top bracing of cross angles, and flat bars bolted on to 3 inch by 2½ inch by ⅜ inch curb-angles.

RIVETERS AT WORK IN THE INTERIOR OF THE STEEL CANAL.

To allow for expansion and contraction the canal is subdivided into seventeen sections, averaging nearly 310 feet each. These are connected together by masonry basins and packed expansion joints. At the end of each section of canal as it enters the masonry basin a stiffening band, 3 feet 4 inches, is riveted on, the external rivet heads being countersunk flush. This band is made to slide in and out of the basin on short sections of rail let into the masonry. The joint is kept tight by means of tarred or tallowed rope packing enclosed between two high and semicircular angles placed back to back with bolts passing through them. The weight of the water flowing through keeps the canal floating on the packing, and each section can therefore expand or contract, according to temperature. In practice, we understand that it has been found that the movement is very small when the canal is running full. The recess containing the angles and the rope packing is slightly tapered, the smaller diameter being outside, so as to prevent the packing from being blown out by the pressure of the water.

ERECTION OF THE LAST SECTION OF THE STEEL CANAL.

As it was impossible to make the riveters efficient with pneumatic tools, nearly all the rivets were put in by hand. For doing this work, Arabs from Cairo and Alexandria, and natives—*fellaheen*—from



FOUNDATION WORK FOR THE WADI KÔM-OMBO IRRIGATION PLANT.

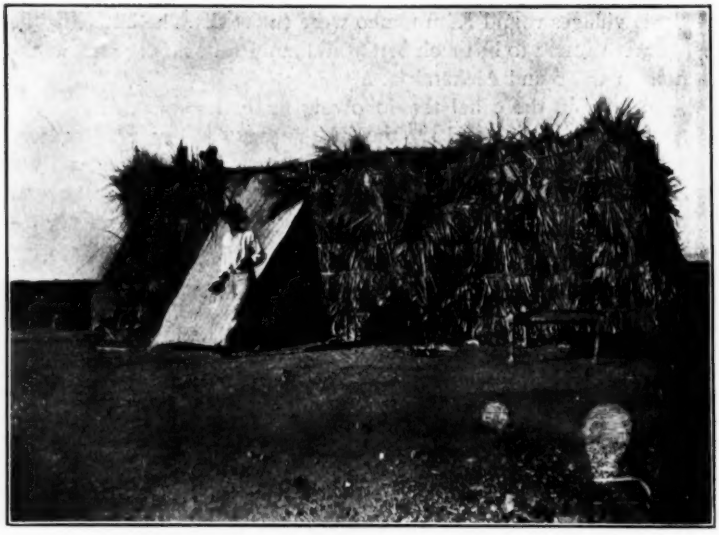
the little villages round Kôm-Ombo were engaged. The latter, on the whole were found to be much better and more reliable than the workmen from Cairo and Alexandria.

For leveling the canal the following method was used:

During the plating and riveting of the plates timber cradles were used to keep the bottom level, and props to prevent the sides from dropping out of shape. The cradles were placed about 30 feet apart. The props were placed under the top curb, and shorter ones were fixed under angle cleats bolted to the first longitudinal seam from the top. As each 310-foot section was completed, together with the masonry basin by which it was connected to the next section, the canal was adjusted to its proper level by means of Haley jacks which were placed along each side of the section, and before the jacks were removed earth was banked up on each side of the canal. To ensure the banks so formed being solid the earth was well watered and rammed tight against the steel work. The amount of fall given to the canal was about 1 centimetre per section of about 310 feet. One great difficulty experienced in keeping the steel canal level during construction was due to the action of the wind, especially during sandstorms on the dry sand which formed the foundation. The wind was able to pass under the canal through the spaces where the sand had been removed to allow room for riveting the cross seams on the bottom plates. This caused the sand to drift and the wood cradles to sink. A 310-foot section would often sink several inches, on this account, during one night.

STAFF SLEEPING QUARTERS.

Another difficulty was due to the unequal expansion of the steel plates owing to the sun's rays affecting the sides of the canal nearest



CHIEF ENGINEER'S QUARTERS DURING BUILDING OF THE INSTALLATION.

to it more than the other side. In some sections the end moved out of centre as much as 4 inches, sometimes one way and sometimes the other. This movement was not arrested entirely until the canal was banked up with earth, and had the water running through it. The canal was painted with two coats of a spirit paint with an asphalt or bitumen base. It is applied cold and dries quickly, and so far experience has proved it to be a very satisfactory coating for this class of work. The total weight of the steel work was 1,250 tons.

The steel canal and mains were carried out by Messrs. Thomas Piggott & Co., of Birmingham. Nearly 1,000 men were employed for erecting the whole plant. An enclosed camp was made close to the site for Europeans, the natives being housed some in tents and some in stone houses called *esbahs*. A chief trouble with these natives was that the different tribes did not get on well together, and fought with sticks and knives on the smallest provocation.

The mean shade temperature during the work was about 117 degrees F., and light wooden screens had to be erected for protecting the workpeople from the sun.

SYSTEMATIC FOUNDRY OPERATION AND FOUNDRY COSTS.

By C. E. Knoeppel.

V. APPORTIONING COSTS TO PRODUCTION IN VARIOUS CLASSES OF FOUNDRIES.

Mr. Knoeppel's series began in our issue for October, 1908, and preceding parts have dealt with the elements of the problems of foundry costing, the importance of correct burden apportionment, and the classification and apportionment of costs.—THE EDITORS.

A MANUFACTURER, whether making castings or candy, is generally inclined to the belief that he can derive no direct benefit from a discussion of proposed betterments, because of his "peculiar" or "complex" conditions, which according to his way of thinking call for specific treatment—if any betterment is necessary.

There is of course no denying the fact that there are many cases where Jones puts into operation methods that are successful in the plant of Smith, and after a heart-breaking attempt to get things to run smoothly under the new arrangement, finally discards them for his old methods with the result that any new innovations thereafter are frowned upon. As a matter of fact, no betterments can be introduced into any business, no matter how correct they may be in principle, if little attention is given to the matter of their application to the existing conditions; and to this one defect of inapplicability—a serious one indeed—can be laid the failure of many a system that was no doubt correct as far as the principle was concerned. An improvement involves a change, although a change does not always imply an improvement; therefore before a manufacturer plans any changes, he wants to feel sure that they are going to better his results and still cover his conditions—he wants them right both in principle and application.

After a consideration of the reasons why methods sometimes fail to accomplish the results that are anticipated, it seems that an analysis of any proposed improvement would materially assist in demonstrating its value or its unfitness, and in doing this, three things are necessary to consider—First, what should be done, second why it should be done, third, how it should be done.

If a proposed method gets through this triple analysis and still appeals to the manufacturer as being valuable, the chances are that

it will bring about the desired results. A manufacturer might decide on what should be done and feel satisfied as to why it should be done, and then stop his investigation and put the method into operation with unsatisfactory results due to a failure to plan out the "how;" or he might plan out a method by deciding on what he wanted to do and how it should be done, and unless he had satisfied himself as to the "why" of it, the method after being in operation for a time might be a failure. If he had first decided on what he wanted to do, then why he wanted to do it that way, and finally planned out with care as to how it should be handled, he would be able to supply himself with about all the arguments for and against the method, to decide him as to the course to pursue—the "why" testing the correctness of the principle; the "how" the logic of the application.

The preceding papers have dwelt upon correct burden apportionment; the elements entering into the burden; their apportionment to production and the necessity for analysis—the "what" and the "why" receiving the most attention. The suggested burden apportionment took into consideration the fact that some of the items were proportionate to direct labor, others to the tonnage produced; that it was advisable to divide the burden into the elements necessary to give the executive an intelligent grasp of all of the pertinent details of his business; and although the suggested division might impress a manufacturer as being "too much detail," the fact remains that we must know *where* to concentrate our attention before we can better results, and that compilations cannot anticipate whether information is going to be valuable or absolutely worthless. Therefore it would be better to divide into three parts an item which could be carried under one heading, if by so doing there is any possibility that one of these subdivisions may point out the way, through analysis, to greater efficiency—the conditions to be covered largely governing the kind and number of accounts. Finally, we saw that analysis of "comparative elements" was an absolute necessity because it took into consideration the fact that first impressions are usually lasting, whether correct or incorrect, and that it is an unwise policy to jump at conclusions unless we can see the conclusions.

Granting the importance of analysis—the correctness of a burden apportionment part to labor and part to tonnage—and the necessity for a detailed division of what is expended, the next feature a foundryman is concerned with is the consideration as to *how* his costs are to be absorbed by his production. In order to treat this phase of the subject as intelligently as possible, it is necessary to divide the foundry industry into different classes as follows:

1. Jobbing Foundries—Foundries selling all their production to outside manufacturing enterprises.
2. Specialty Foundries—Foundries selling all their production to the business of which they are a part.
3. Specialty Foundries Doing a Jobbing Business—Foundries selling part of their production to outside manufacturing enterprises and the balance to the business of which they are a part.

There seems to be little uniformity in foundries in the above classes when the matter of the division of the production is considered. Some foundrymen want it divided one way, while others have some other method of ascertaining the cost of different kinds of production; in fact, a half-dozen foundries in the same locality may have as many different ways of figuring. The following are the principal divisions of the several ways possible for a foundryman to treat his production, applicable to the three classes of foundries specified above:

(*a*) Cases where a foundryman is satisfied with simply the *weight* and cost of his production *in total.*

(*b*) Cases where the production is *classified* according to *weight* and is divided into—

Total weight and cost of "light" work.
Total weight and cost of "heavy" work.

(*c*) Cases where the production is classified according to the principal *methods of moulding,* being divided into—

Total weight and cost of loam work.
Total weight and cost of dry sand work.
Total weight and cost of green sand work.

(*d*) Cases where the production is classified according to the *use* of the castings produced, being divided as follows (if we assume for example, a concern manufacturing engines and boilers)—

Total weight and cost of engine castings.
Total weight and cost of boiler castings.

Or if the output consists of a varying line such as the manufacture of steam and gas engines, boilers, and a special line of work such as laundry machinery, we can divide—

Total weight and cost of steam-engine castings.
Total weight and cost of gas-engine castings.
Total weight and cost of boiler castings.
Total weight and cost of laundry-machinery castings.

Or we can still further classify by taking the production of the steam-engine castings according to—

Total weight and costs of beds.
Total weight and cost of frames.
Total weight and cost of wheels.
Total weight and cost of cylinders.
Total weight and cost of all other steam-engine castings.

(*e*) Cases where the production is classified according to the *way the castings are made,* being divided into—
Total weight and cost of machine-made castings.
Total weight and cost of hand-made castings.

(*f*) Cases where the production is classified according to the weight and cost of *each separate casting.*

(*g*) Cases where the production is classified according to the total weight and cost of *each customer's work.*

(*h*) Cases where the production is classified according to the *departments* in which they are made, as for example—
Total weight and cost of bench work castings.
Total weight and cost of side-floor work.
Total weight and cost of main-floor work.

(*i*) Cases where the production is classified according to the various *classes of weights,* as for instance all castings weighing from 200-400 pounds being treated as in a class by themselves.

(*j*) Cases where the production is classified according to the *disposition,* being divided into—
Total weight and cost of castings made for our own consumption.
Total weight and cost of castings made for sale to the trade.

If space permitted, various combinations of the cases shown could be cited as for instance *j* and *b* could be combined, the castings made for sale and consumption being in turn divided into the weight and cost of the light and heavy work. Care should be exercised before deciding on what case or combination of cases to use, as conditions (and conditions only) must govern the plan to follow.

The following rules have been worked out in order that the calculations entering into the apportionment of costs to production, may be more clearly understood, our known elements being—

1. Weight of castings produced.
2. Total cost of Direct Material.
3. Total cost of Direct Labor.
4. Total cost of Foundry Charge.
5. Total cost of Tonnage Charge.
6. Total cost of Commercial Cost.

RULES FOR RATE DETERMINATION.

1.—To find the rate per 1,000 pounds of Direct Material, divide the cost in total of Direct Material by the tonnage produced.
2.—To find the rate in per cent of Foundry Charge, divide the cost in total of Foundry Charge by the cost in total of Direct Labor.
3.—To find the rate per 1,000 pounds of Tonnage Charge, divide the cost in total of Tonnage Charge by the tonnage produced.
4.—To find rate in per cent of Commercial Cost, divide the cost in total of Commercial Cost by the cost in total of Direct Labor.
5.—To find the rate per 1,000 pounds of Total Cost, divide the total cost by the tonnage produced.

APPORTIONMENTS.

6.—To ascertain the cost of Direct Material, multiply the tonnage produced by the rate from Rule 1.
7.—To ascertain the cost of Direct Labor, charge the proper amount direct.
8.—To ascertain the Foundry Charge, multiply the Direct Labor by the rate from Rule 2.
9.—To ascertain the Tonnage Charge, multiply the tonnage produced by the rate from Rule 3.
10.—To ascertain the Commercial Cost, multiply the Direct Labor by the rate from Rule 4.

After the rates have been determined, the following rules can be used for enabling the foundryman to cost correctly any classified production:

RULES FOR THE TREATMENT OF THE VARIOUS CASES.

11.—Select from list previously shown—cases *a-j*, the division desired.
12.—Classify the production according to the division selected.
13.—Ascertain the Direct Material cost by using Rule 6 for each classification.
14.—Post to each classification the correct amount of Direct Labor.
15.—Apportion Foundry Charge by using Rule 8.
16.—Apportion Tonnage Charge by using Rule 9.
17.—Apportion Commercial Cost by using Rule 10.
18.—Add 13-17 inclusive.
19.—For rate per 1,000 pounds of Total Cost, use Rule 5.
Rules 15-19 inclusive apply to each classification separately.

ILLUSTRATION.

Values.	Apportionment.	
Tonnage—3,050 lbs.	Tonnage—$3,050 lbs.	
Direct Material—$10.00 per 1,000 lbs.	Direct Material	$30.50
Direct Labor—$20.00.	Direct Labor	20.00
Foundry Charge—125 per cent.	Foundry Charge	25.00
Tonnage Charge—$2.50 per 1,000 lbs.	Tonnage Charge	7.63
Commercial Cost—35 per cent.	SHOP COST	83.13
	Commercial Cost	7.00
	TOTAL COST	90.13
	Per 1,000 lbs	29.55

Through the use of the above rules, a foundryman is in a position to determine the costs of his production, in total as in Case *a*, as one extreme (hardly to be recommended, however), or by each individual casting as in Case *f*, as the other extreme. He would

have in any case other than Case *a* a classified cost of his production, the amount of detail work necessary to secure the costs depending upon the selection from the list of cases; and as outlined, the costing would take into consideration the fact that the production, though classified, was the output of a single department.

If, however, the foundryman found it necessary, because of his conditions, to obtain *all* the information possible to secure, it would then be necessary to divide the foundry into certain departments. Take for instance a foundry where a number of machines are in use; where a considerable amount of bench work is done, but where the bulk of the work is light and heavy floor work. It would then be well to divide the foundry into Machine, Bench and Floor departments, and each in turn could have its production classified according to one or more of the cases previously shown. To treat the foundry as made up of these three departments, it would be necessary to make a number of separations in the figures. The cost of Direct Material and Labor would be separated into the costs for the three departments, by divisions decided upon, while the other three items—Foundry Charge, Tonnage Charge, and the Commercial Cost, would have to be separated as far as possible into—First, the costs which could be charged direct to the three departments, and second, the costs of a general nature which would have to be apportioned to the production of each department.

A brief analysis of the cost accounts which appeared in the third paper will show that there are several elements which could be charged direct to the departments; others could be charged part to the departments and part to the "general" section, while still others would have to be included in the "general" section. Each individual case would of course determine the divisions, but in a general way the apportionment shown on page 771 would be a representative illustration of the items which would appear as direct, direct-general, and general charges.

After the costing has been done along the lines suggested, it will be found that the departments are charged with the proper amount of Direct Material, Direct Labor, and a portion of the Foundry Charge, Tonnage Charge, and Commercial Cost, and in order that the production of the departments may absorb all the expenses, it will be necessary to distribute the remaining portion of the three latter elements in the "general" section, in such a manner as shall give to each department an equitable amount. To do this Direct Labor can be used as the basis for distributing the Foundry Charge and Commercial Cost items, while the Tonnage Charge items are distributed on the

basis of tonnage produced. This seems to be fair, as the department having the largest amount of Direct Labor and tonnage would have to stand the largest amount of these expenses apportionable to labor and tonnage which could not be charged direct.

FOUNDRY CHARGE.

Direct to departments—
Power Plant, Shipping, Rigging, Taxes and Insurance.
Part direct to departments and the balance to "general"—
Cleaning Labor, Chipping, Shop Supervision and Clerical, Foundry, General and Cleaning Room Supplies.
General—
Maintenance of Buildings, Plant Equipment, Power and Transmission Machinery and Cast Equipment; Stable, Pattern Shop, Machine Shop, Carpenter Shop, Blacksmith Shop, Pattern Storage and Depreciation.

TONNAGE CHARGE.

Direct to departments—
Replace Labor, Night Gang, Foundry Supplies, Core Room Supplies on the basis of the Core Labor in each department and Maintenance of Patterns.
Part direct to departments and the balance to "general"—
Maintenance of Flasks.
General—
Cupola Labor, Handling Materials, Yard Labor, Cupola Supplies, Power Plant and Analysis Expense.

COMMERCIAL COST.

All of the Administrative to "general."
All of the Selling direct to the departments where possible and the balance to "general."

The following rules can be used for distributing to the departments, the Foundry Charge, Tonnage Charge, and the Commercial Cost items in the "general" section:

1.—For Foundry Charge and Commercial Cost—
A—Direct Labor in the Machine Department.
B— " " " " Bench Department.
C— " " " " Floor Department.
D—Total Direct Labor (A + B + C).

$$\frac{A}{D}\ \frac{B}{D}\ \frac{C}{D} = \text{Departmental rates in per cent.}$$

Distribute to each department, using the rates ascertained, the proper proportion of the Foundry Charge and Commercial Cost, treating each expense element separately.

2.—For Tonnage Charge—
E—Tonnage in Machine Department.
F— " " Bench Department.
G— " " Floor Department.
H—Total tonnage produced (E + F + G).

$$\frac{E}{H}\ \frac{F}{H}\ \frac{G}{H} = \text{Departmental rates in per cent.}$$

Distribute to each department, using the rates ascertained, the proper proportion of the Tonnage Charge, treating each expense element separately.

3.—For each department, add the amounts charged direct and distributed, according to the following classes—Direct Material, Direct Labor, Foundry Charge, Tonnage Charge and Commercial Cost.

We are now in possession of three sets of figures covering the three departments, and to get at the detailed costs of the product of each of them, use the rules 11-19 inclusive by simply adding the words "for each departments" as, for example: (Rule 11)—"Select from the list previously shown—cases *a-j*—the division desired, for each department," and after the rates per 1,000 pounds have been ascertained for each classification of the production in each of the three departments, the foundryman will be in possession of what he wants to know regarding his costs to produce.

Each foundryman must determine for himself, from his conditions, whether he wants to treat his foundry as a single department or to divide it into several. If the principal requirement is almost absolute accuracy regardless of the detail necessary, and the proposition is a large one, then there is no question but that the accounting should consider the foundry as made up of several departments. If, however, the foundry executive does not want to go into the detail that is necessary to departmentalize his foundry, and if costs are wanted that are fair and within reason, the foundryman can then consider his foundry as one department with a classified output, which will give the results he wants at a minimum expenditure.

While not within the province of this article to lay down hard and fast rules as to specific treatment, the following is offered for foundries considered as a single department, as a means of covering the ordinary conditions that are met with in the three classes of foundries previously mentioned:

1.—Foundries under Class 1, classify production according to Case *g* (customers' work) with provision to treat certain work according to Case *f* (individual castings).

2.—Foundries under Class 2, classify according to Case *d* (use).

3.—Foundries under Class 3, classify production as shown at 1.—for jobbing work, and at 2.—for work for consumption by the business of which the foundry is a part.

Through the methods above suggested, we get at the end of a period, for Class 1 foundries, the cost of production by customers, which cost is offset by the price at which the work is sold to the trade, the difference establishing the desirability of the work in question as well as the places where attention must be concentrated; and as provision can easily be made for ascertaining the cost of certain castings for certain customers, the foundryman has in his possession, through the classification suggested, the information necessary to improve where necessary, the conditions determining *how* he shall improve. We also get at the end of a period, for Class B foundries, the cost of the castings for the machine or boiler shop, according to

the use, which cost is offset by the price allowed the foundry and charged to the departments using the castings.

Few appreciate the fact that consumption of castings should be at rates which recognize the difference in the cost to produce them, so that it seems important that our costing take this difference into consideration. A clothier because he purchases 100 suits at $15 each, 100 suits at $20, 100 suits at $25, and 100 suits at $30, will not sell them at $27 each simply because $27 means the average cost of $22.50 plus 20 per cent profit. Assuming, however, that he did this, on his $15 suits he would make $1,200; on the $20 suits he would make $700; on the $25 suits he would make $200, while on the $30 suits he would *lose* $300, and as a result he would have $1,800 profit in all. The chances are that he would have a hard time disposing of $15 and $20 suits at $27; while because of the quality, his customers would jump at the chance of buying $25 and $30 suits at $27. At any rate, on his two most expensive lines he would make $200 and lose $300, and he would perhaps have to trust to good fortune and "sales" to dispose of the others; so that by the time he had sold them all, he would very likely find that he was a long way from making his 20 per cent. Instead of this, our clothier would take each cost and add his profit, and if a man wanted a cheap suit, he would pay a price that would net a profit of 20 per cent, which would also be the case should a man want a more expensive garment, and when the suits were all disposed of, the clothier would find that he had made a profit of $1,800 on his investment.

This illustration applies to machinery manufacturers making their own castings. An average cost, because of the word "average," means that some cost more and others less, and there seems to be no consistent reason why the difference should not be observed. Assume that in a machine shop two lines are being manufactured—one a steam engine of simple construction, and the other a gas engine of intricate and complicated design; it will be found that the castings for the first line will cost considerably less than the castings for the gas engines. If the steam engine castings cost $2.25 per 100 pounds and the gas-engine castings $2.75, why use an average of $2.50 for all? A difference of $5.00 per ton either way is something to think about when the total weight of the castings in the engines is taken into consideration, for on the steam-engine castings it would mean a reduced cost of the finished engine, which would either result in a greater profit, if the regular price is obtainable, or the *same* profit on a larger number of sales, due to a decreased price; and while the cost of the finished gas engines would be greater, necessi-

tating a higher price, it is reasonable to ask the consumer to pay the most for that which cost the most to produce, especially when it is a complicated proposition of superior design and workmanship, enabling the manufacturer to talk quality.

I wish to emphasize, at this point, the importance of treating *all* foundries as *jobbing* foundries. If a machine shop is purchasing its castings from an outside foundry for $2.70 per 100 pounds, this figure is naturally used by the machine shop in figuring the cost of the cast iron in the machine. Should a foundry be built and operated, the person who is placed in charge of the foundry may, through efficient management, turn out a production costing $2.45 per 100 pounds. These same castings, purchased outside, cost $2.70; therefore the castings that are made are worth this same amount to the company, the foundry being entitled to a credit of $ .25 per 100 pounds as the difference between what these castings are worth and what they actually cost to make. Suppose, for instance, a certain machine selling for $2,000 contains 20,000 pounds of cast iron which at $2.70 per 100 pounds would mean $540 as the cost of this material. Would it be good business, if the machine had a ready sale, to reduce the price by $50 simply because the castings are being made for $5.00 a ton less? Or would it be better to treat this saving as a profit—which, in reality it is—and as such having nothing whatever to do with the matter of price? The latter method seems the most logical, and if any cut in price is necessary it should be at the expense of the department getting the credit for the sale.

In estimating, market conditions largely prevail; and there seems to be no good reason why a price of $2.45 should be used instead of $2.70, if this latter quotation is near the market figure. A sales manager recently stated that whenever he bid on a job which contained considerable cast iron, he was generally able to get the work—in fact the orders seemed to fall into his lap. This led him to think over the situation, and he found that his competitors were using a *greater* rate for cast iron than he was. Investigating still further, he learned that he was using the actual foundry cost figures—which was not a complete cost by any means—instead of the rate that he would have been forced to use had his company been purchasing the castings, with the result that he had, unknowingly, been "doing" his company out of profits which would have been made had the rate been higher. At any rate, the cost figures were increased without any apparent reduction in sales.

On the other hand, suppose on account of a low tonnage or other reasons the castings should cost $2.90 instead of $2.70. Would it do

to charge the machine shop with castings at $2.90—an increase in the cost of $4.00 per ton—or make the foundry stand this loss by charging the machine shop with castings at $2.70, in this way costing up the work at a price for which the castings could be purchased outside? It would certainly not do to take the $2.90 price into consideration for estimating purposes, because of the fact that the competition might be using a price around the $2.70 mark—the difference amounting to quite a little on an order of any size. At any rate there is no getting away from the fact that a loss has been made, for if castings which cost $2.90 to make can be purchased for $2.70—and only good ones at that—then $4.00 per ton is being thrown away; and as the machine shop is in no way to blame for this loss, we should make the department producing these castings stand whatever the loss might amount to. If the foundry is to take care of its own losses, *then the foundry is entitled to any profits it might make.*

The foundry should therefore be considered as a producing department, in the same sense that the machine shop is a producing department, instead of treating it as an adjunct of the machine shop. It should be carried as a separate department through the general books of the company, in this way placing the foundry squarely on its own feet—side by side with the machine shop, a position it is most certainly entitled to—besides furnishing the proper incentive to each and every man, from the foundry superintendent down to the apprentices, for the reason that they feel that if all do their share in making a success they can participate in that success through increases in pay. In addition such a procedure gives to the management a means for determining the efficiency of its foundry department, as well as deciding them as to whether it would be policy to close their foundry and purchase their castings elsewhere. It also places the foundry on about the same basis as outside foundries, which not only tends to make estimation more uniform, but competition more intelligent.

To carry the foundry properly through the books of a manufacturing company, I would suggest that two accounts be opened as General Ledger accounts—Foundry Manufacturing Account, and Foundry Income Account, and as a large number of concerns are beginning to treat all materials as "stores" until used, the plan should be to sell monthly to "stores," as "castings," the total output of the foundry at a price that will correspond as closely as possible with the price that would have to be paid for purchased castings. To illustrate: assume that the foundry produced 300 tons in a month at a cost of $48.00 per ton, or $14.400, the divisions being—materials, $6,000; labor, $3,900, and expenses, $4,500—the price allowed the

foundry being $2.65 per 100 pounds, or $53.00 per ton. Our Journal entries would read:

	Charges.	Credits.
(1) Foundry Mfg. Acct..300 tons produced @ $48.00 ton....$14,400		
Stores Acct.....		$6,000
Labor Acct.....		3,900
Burden		4,500
(2) Stores .....300 tons purchased @ $53.00 ton..$15,900		
(3) Foundry Mfg. Acct..300 tons sold to Stores.....		$15,900
(4) Foundry Mfg. Acct..Profit, month's production..... $1,500		
(5) Foundry Income Acct.—Monthly profit 300 tons.....		1,500

LEDGER ACCOUNTS.

Stores.

(2) 300 tons castings purchased from fdry @ $53.00 per ton.....	$15,900

Foundry Mfg. Accr.

(1) 300 tons produced @ $48.00 per ton.....	$14,400	(3) 300 tons sold to Stores— $53.00 per ton.....	$15,900
(4) Monthly profit.....	1,500		
	$15,900		$15,900

Foundry Income Acct.

(5) Monthly profit 300 tons.	$1,500

Before concluding, it might be well to state that in determining the cost of production in foundries in Class 2 and 3, consideration should be given to the fact that there are no selling expenses to be added to the production made for use for the business of which the foundry is a part, because of the fact that this expense is necessary in marketing the finished product of the machine or boiler shop, for which reason it would be a charge against the production of these departments and not against that of the foundry—the business really buying, as before stated, the entire monthly production of the foundry, this transaction being one in effect only, involving the expenditure of no money whatever as a selling expense. Defective castings returned from the machine or boiler shop because of defective workmanship in the foundry—the only selling expense element, the specialty foundry has to deal with—would be treated as "foundry errors" and included in the Foundry Charge section, at the price less scrap value. Foundries in these same classes, in the absence of an organization of their own, should be made to stand a portion of the general administrative expenditure—a combination of judgment and an analysis of the items making up this element, to determine the proper proportion to charge to the Foundry Department.

* Figures show Journal entries and corresponding postings.

THE USES OF MECHANICAL REFRIGERATION IN METALLURGICAL PRACTICE.

By Jos. H. Hart.

The opening of a new field for a mechanical operation may be as important in its significance as the original development. In the applications suggested by Dr. Hart, the possible results in economy to the mining and metal industries are even larger than those appealing to the producers of refrigerating machinery.—The Editors.

THE recent granting of letters patent to Franklin R. Carpenter for the utilization of mechanical refrigeration in the condensation of smelter fumes opens a field of application for mechanical refrigeration which has seldom been considered before, and the extent and character of its possible service in this field is scarcely realized by even the specialist.

The utilization of mechanical refrigeration for the condensation of the moisture from the blast in iron-furnace operation, known as the Gayley process, is fairly well-known today by operating engineers in this field, but the remarkable efficiency attained by the process and the wide extent of its present development are almost equally unknown. A 15 to 20 per cent increase in furnace capacity, with a 10 to 15 per cent decrease in coal consumption per ton of iron produced, define only one of its remarkable features. The further fact that the horse power of the blower required for the operation of the blast furnace is reduced to such an extent that generally two-thirds of the power saved is quite sufficient to operate the refrigerating machine is but another instance of its remarkable efficiency. Plants have been installed in the Illinois Steel Company's works, the Warwick Iron and Steel Company, the G. & H. Brooke Company, and practically every iron and steel-manufacturing company in the United States is either seriously contemplating the installation of such a plant or has already begun its installation. In addition, the firm of Gues, Keen & Nettlefolds, Ltd., of Cardiff, Wales, have recently installed the same system, under the supervision of the same engineers who have put in the plants in America. These plants range from several hundred tons up to over eight hundred tons refrigerating capacity and are among the largest in existence. The further recent test at the Illinois Steel Company's works of the utilization of a refrigerating machine for the removal of the moisture from the blast in crucible operation was

equally productive of good results and showed an efficiency which is likely to revolutionize operations in this field.

As has been said, the letters patent issued to Mr. Carpenter are but a further step in this direction and open enormous fields for possible development. The chief ingredient which it is desired to remove from the exhaust gases in smelter-furnace operation is sulphur, or rather, sulphur dioxide, as it exists under this condition. Arsenic is also present, and in many furnaces a large number of the rarer metals or chemical elements such as selenium, etc., pass off in the furnace gases and flue dust. The amount of sulphur daily wasted in smelting work is something appalling. A single plant near Salt Lake City discharges nearly 500 tons of sulphur, as SO_2, into the atmosphere every 24 hours, while the Washoe, Garfield, and other plants probably exceed this. In that particular installation at Salt Lake, the discharge of the sulphur fumes has been the cause of considerable litigation. The Mormons have large salt-evaporating beds here, where the salt is produced by solar evaporation from the water of the Great Salt Lake. The salt company claims that the pollution of the atmosphere by SO_2, and its consequent deposition and chemical reaction, result in considerable deterioration of the salt product. Sulphur fumes undoubtedly destroy vegetation to a very great extent. The question has been raised as to whether damage is done by sulphurous acid or other poisonous fumes, but in some well-known cases the ores are singularly free from arsenic and other deleterious substances. Up to date practically no scheme has been devised for the satisfactory utilization of the SO_2 in the Salt Lake smelter, and operation has been absolutely prevented for a considerable time by legal processes.

The utilization of sulphur fumes is an old question, and no satisfactory solution has been made other than the production of sulphuric acid, which has been a fairly efficient and economic process where a sufficient market exists for this product at moderate freight rates. Sulphuric acid, however, sells at from two to five cents per pound, depending on the character and concentration of the acid, and in very many localities the freight rates to a satisfactory market are absolutely prohibitive. Fumes from ordinary pyritic smelters vary from four to seven per cent of SO_2 gas, while those from muffle roasters of zinc ores and those of the pot roasters are considerably higher, but all can be easily used in the manufacture of sulphuric acid. The ordinary chamber process is the one usually employed, but the Winkler or catalytic process has been introduced, which

gives a fairly pure acid practically without attention and the materials used in its manufacture operate in a closed cycle with comparatively little loss. The utilization of mechanical refrigeration in this connection is the result of an attempt to obtain the free sulphur from the SO_2. Five hundred tons of sulphur present in the form of SO_2 means about 1,500 tons when transformed into sulphuric acid, and it is impossible to get rid of this in the streams or by any satisfactory process. Sulphur, on the other hand, has an equally wide market and the 500 tons wasted in this single plant every 24 hours has a market value of $10,000 if available.

Sulphur dioxide possesses the property of freezing out of its gaseous form at—10 degrees C. It is proposed to pass sulphur dioxide thus produced through a reducing chamber, with the elimination of the oxygen, or to transform a portion of this to H_2S and have the interaction between this and the SO_2 occur according to the well-known formula, with the production of free sulphur. The refrigerating capacity required for this purpose would be extremely large, since the hot flue gases would have to be cooled to this point, but undoubtedly the heat of these gases could be used to produce the work of refrigeration itself. Some adaptation of the absorption type, whereby the hot exhaust gases could be used efficiently instead of steam in the generation of the ammonia gas, will open a wide field for cultivation in this and allied fields.

The real development in the application of mechanical refrigeration to chemical processes has scarcely commenced. Practically all volatile chemical compounds today are caught and retained by means of their solubility in water or some other solvent. Thus hydrochloric acid is now produced by means of sulphuric acid acting on one or more of the common salts, with the consequent production of HCl in gaseous form. This is caught and held for commercial purposes only by means of its affinity for water, the ordinary commercial acid containing 43 per cent of the latter constituent. In practically all of these processes, concentrated products are the thing desired. In a general way they are not obtained by the ordinary methods without considerable loss in the exhaust vapors, or by extreme concentration by boiling after collection. The statements made in regard to the production of hydrochloric acid and the advantages to be obtained in the use of mechanical refrigeration in this connection hold equally in a wide variety of other chemical reactions. The production of aqua ammonia as a by-product from ordinary gas is rendered necessary in the ordinary cleaning mechanism for the gas.

The use of mechanical refrigeration in this field, with the consequent production of liquid ammonia itself by means of its own refrigerating power, is a possibility offering great economies, and these are generally of a character and order such as has been obtained in the Gayley system of removal of moisture in blast-furnace operation.

The suggestion has also been made that exhaust gases from furnaces can be cleansed for this purpose before utilization in the ordinary gas engine. The same or similar conditions hold equally in regard to the purification and cleansing of the gases from the ordinary water-gas or fuel-gas furnace, with a resulting increase in the efficiency of utilization of the gas in the production of power, as well as in the return of a considerable revenue from the products so obtained. The suggestion that the Gayley process is equally available for freezing the moisture out of air in preparation for its compression in the ordinary air-compression plant, as utilized in many mining installations, offers possibilities of efficiency not only from the removal of the vapor but on account of the increased density and consequently enlarged capacity of a given cylinder for air compression. It offers also a possibility of increased efficiency in the operation of the compressor itself. The further utilization of mechanical refrigeration is possible in the operation of condensers and in maintaining a low temperature in these, with consequent increase in efficiency of the condensing process and with enlarged capacity of the unit, whether for the production of work (which is largely a theoretical condition) or for increased capacity in the operation and efficiency of such units as sugar evaporating pans, vacuum kettles in both the condensed-milk and candy industries, and in a large number of other processes. The application in a much wider range of developments in the oil-refining industry is well-known, and the recent installation of refrigerating machines for the maintenance of the hygrometric conditions and constant temperature in the wash room of silk-dyeing establishments is equally important. In fact, it can be said in a general way that the recent applications of mechanical refrigeration for the control of hygrometric variations in water vapor and in temperature and pressure variations in this and other cases present an opportunity in mechanical refrigeration which is of the greatest importance, and probably more far-reaching in its future influence on the development in this field than a large number of direct applications considered as a whole. The future of mechanical refrigeration is remarkably bright, and new uses and possibilities of still others are daily presented to the operating refrigerating engineer.

MEANS AND METHODS FOR HEATING THE FEED-WATER OF STEAM ROLLERS.

By Reginald Pelham Bolton.

III. FEED HEATING BY USED OR WASTED STEAM.

In the two parts of Mr. Bolton's review of means and methods for feed-water heating already presented, he has dealt with the economy of utilizing for this purpose the heat in the waste furnace gases, and of feed heating by the use of live steam drawn from the boilers or of partially used steam taken from the intermediate receiver of multi-cylinder engines. In this his concluding section, Mr. Bolton examines the economy of feed heating by means of exhaust steam. His general conclusion to the whole study is that the subject offers a fruitful field for the ingenuity and abilities of steam engineers, and discussion of this series of papers will be welcomed both by Mr. Bolton and by the editors of THE ENGINEERING MAGAZINE.—THE EDITORS.

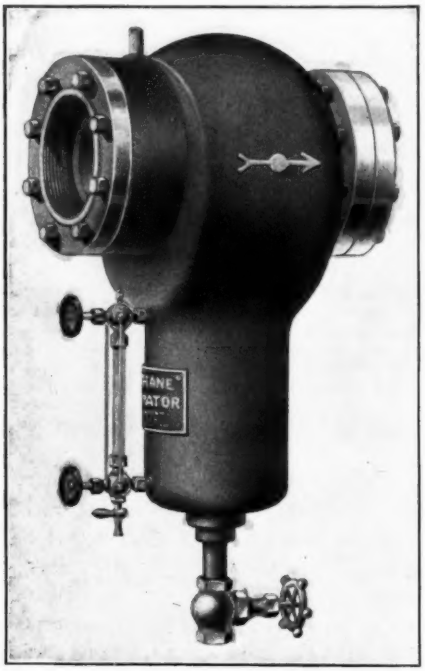
THE utilization of waste heat in exhaust steam is a recognized and substantial source of economy, which needs no argument to prove its value. The methods by which it may best be accomplished, and by which it may be supplemented by other waste heats, are very varied and afford opportunity for the exercise of detailed attention, which is too often denied to the problem, especially where combinations of heat-returning appliances are to be made effective in connection with condensing engines.

The process of heat return to the boiler should include provision for the release of air and gases, and should also at some point afford a certain storage of the heated water so that sediment may be allowed to precipitate, and, further, effective means must be secured for the removal of oil.

In general marine practice, these functions are performed by the hot-well, supplemented in many cases by similar effects at a higher temperature in the contact feed-heater.

The removal of cylinder oil from exhaust steam has appeared to some engineers to be a difficult or doubtful element, but no difficulty need be experienced in accomplishing an effective removal, provided oil eliminators of proper size are used and are effectively and freely drained of the emulsion of condensation and oil, which the appliance will separate from the steam.

It does not seem to be the practice, nor is it appreciated that in the use of closed or surface heaters there is need, to protect the



THE COCHRANE VACUUM OIL SEPARATOR.

For removing oil from exhaust steam, making it suitable for use in heating, boiler-feeding and like purposes. Harrison Safety Boiler Works, Phila., Pa.

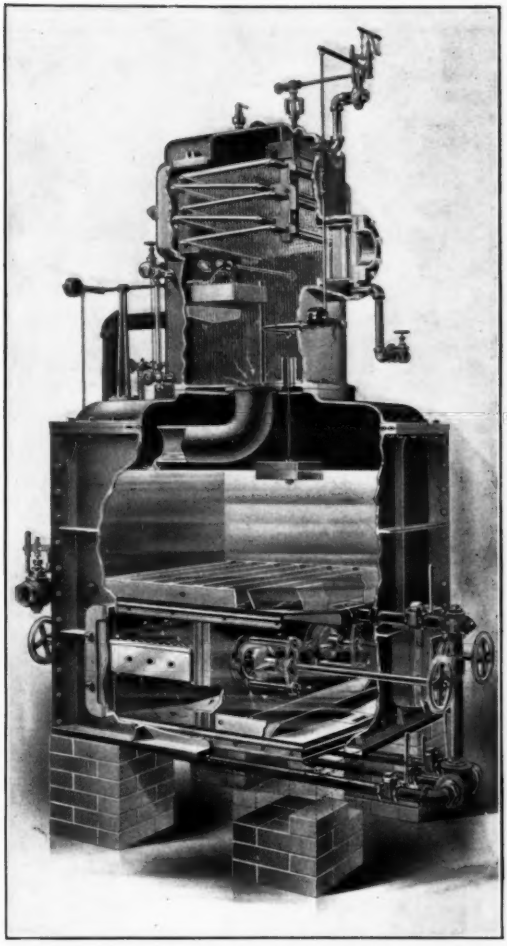
appliance against the entrance of oil in the exhaust steam; for unless this be done, the heat-transmitting surfaces are soon coated with oily deposit, greatly reducing their effectiveness, and as is not infrequently found, the entire lower portion of a heater may, by neglect, become choked with such material. It is customary to allow a considerable margin of heating surface to cover such contingencies, but the proportions should nevertheless admit of a proper speed of the water over the surfaces, or the whole appliance is reduced in effectiveness.

There is usually a difficulty in the utilization of the drip from such heaters, on account of its greasiness, and in a majority of instances it is run to waste. It might, however, with advantage be passed through a coil in a feed-tank, or be united with other foul drips in a drip-tank, in which a coil may be arranged through which the feed-water supply is drawn.

The closed or surface heater has many useful applications, and is a practical necessity if the feed temperature can be by any means raised above the boiling point, for difficulty occurs with pump operation when supplied with super-heated water, due to the formation of steam as soon as pressure is reduced in the valve-chambers of the pump. But as a means of securing all the advantages of waste heat in exhaust steam, and also in the collection of heated waste drips and separator discharges, it is not equal to the contact heater, even if its own condensation be treated as I have suggested.

One of the best and most definite tests which afford means of

ascertaining the available sources of waste heat, as compared with that utilized in the main engines, is that of the steamship Pennsylvania, now the steamship Mataafa, reported in Vol. XI., part 3, of the *Journal of the American Society of Naval Engineers*. This large steamship was fitted with water-tube boilers, supplying saturated steam to a five-cylinder quadruple-expansion condensing engine, and also to a complement of the usual marine auxiliaries, including a fan-engine, the exhaust of which was discharged under the furnaces and was thus lost to the return system, though doing some useful work in connection with the furnace part of the combined apparatus by increasing the draft under the boilers.



WEBSTER CHEMICAL PURIFIER AND FEED-WATER HEATER. The upper part is the regular heating chamber, impurities being precipitated by chemicals automatically fed in here, and being deposited on the inclined precipitating plates; thence the water passes downward over smaller plates to the filter, and through it upwards to the hot-water outlet chamber. The filtering material is crushed quartz held in cotton twilled bags between perforated metal sheets. The apparatus is duplex, either half being ample in capacity for the service. Warren Webster & Co., Camden, N. J.

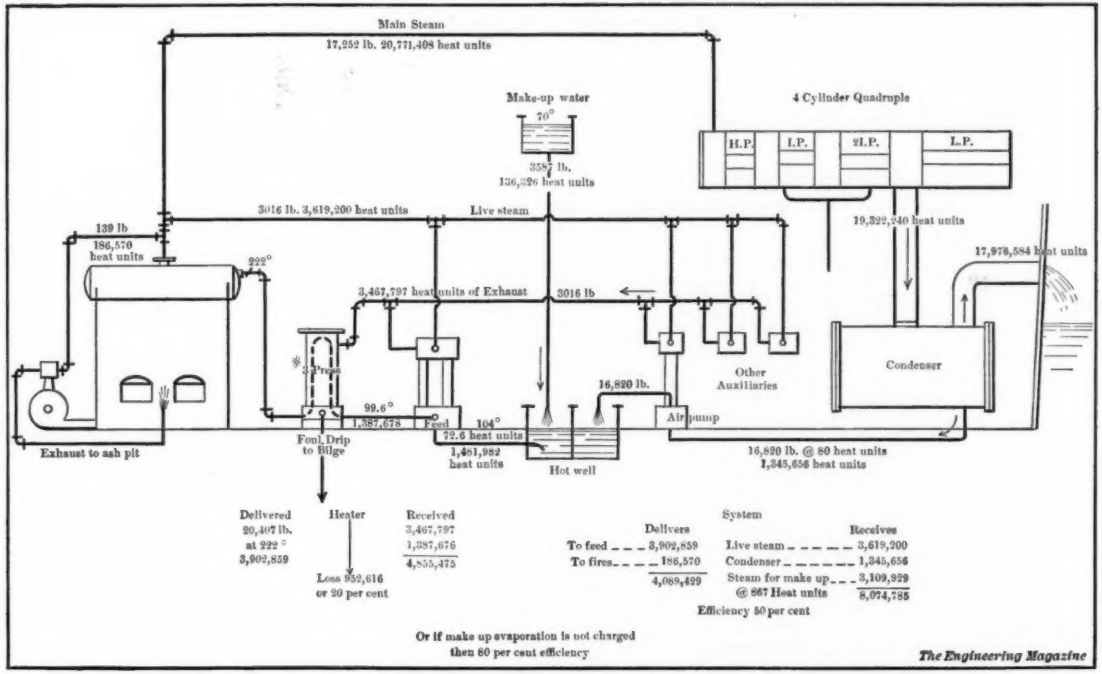
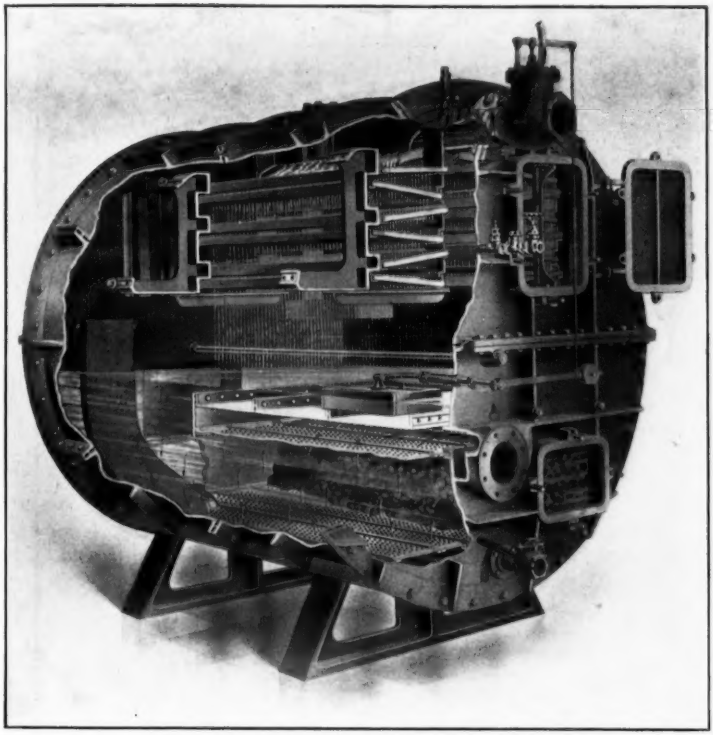


CHART VI. USE OF CLOSED OR SURFACE HEATER WITH EXHAUST STEAM (STEAMSHIP PENNSYLVANIA TEST CONDITIONS).



WEBSTER FEED-WATER HEATER FOR CAPACITIES FROM 500 TO 10,000 HORSE POWER.
Warren Webster & Co., Camden, N. J.

It was found that when the main engines were receiving a supply of 17,252 pounds, the auxiliaries absorbed an additional amount of 3,016 pounds of steam per hour, to which was added 139 pounds taken by the blower engine. The auxiliaries proper, therefore, used 15 pounds to each 100 which the main engines demanded.

The heat cycle is shown in Chart VI., the feed-water on its way to the boiler being pumped through a surface or closed heater, in which the above recorded exhaust of the auxiliaries was condensed, and by which the feed-water was raised to a temperature of 222 degrees F. It will be seen that the use of this closed heater involved the loss of the weight and of the contained heat of the condensed exhaust, and the consequent introduction into the system of make-up water to that extent.

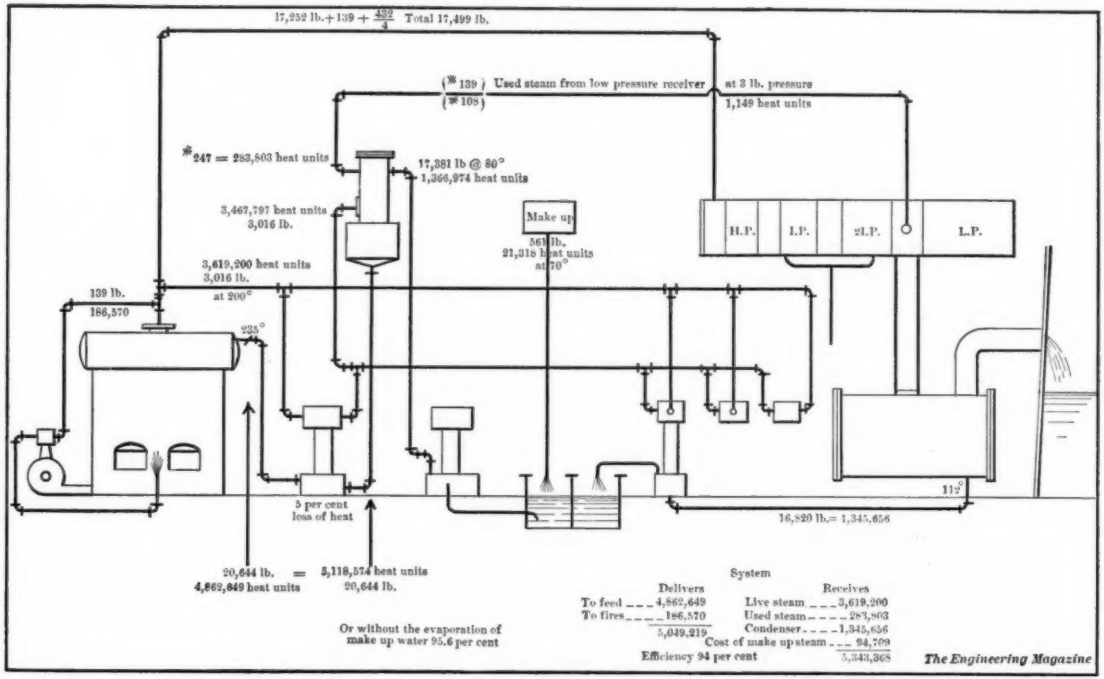


CHART VII. USE OF OPEN OR CONTACT HEATER WITH LOW-PRESSURE STEAM (STEAMSHIP PENNSYLVANIA CONDITIONS).

On the trial, this seems to have been introduced at 70 degrees F. from a stored supply, and allowing for this element, the heat-saving efficiency is 80 per cent. But inasmuch as such a supply would in other cases have cost heat for its production by evaporation, the cost in heat for such evaporated make-up may be added in the heat balance, and the whole system would then work out to a heat-saving efficiency of only 50 per cent.

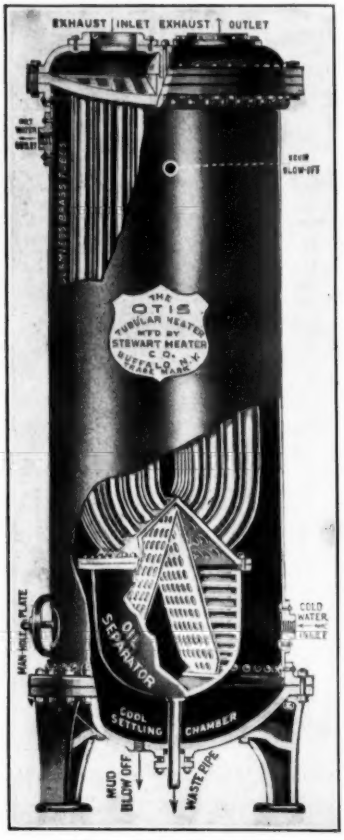
REILLY MULTICOIL FEED-WATER HEATER.
The Griscom-Spencer Co., N. Y.

In Chart VII. the same heat quantities are applied, with the substitution of a contact heater in place of the closed heater, involving the addition of a hot-well pump, the work in which, however, is practically part of that of the boiler feed-pump, as the lifted water descends to the latter with the head due to the position of the contact heater, usually high up in the fiddler casing. The result is to bring the system, inclusive of make-up evaporation, to an efficiency of heat saving of 78 per cent.

A further advance could be made on this economic result by the application to the system of partly-used steam from the low-pressure receiver, whereby, as shown in Chart VII., the feed temperature could be raised to 235 degrees, with an increase of heat-saving efficiency to 94 per cent. This result may be compared with that obtained with the various devices employed on the Inch Line steamships, which showed a heat-saving efficiency of 86 per cent.

The author of "Triple and Quadruple Expansion Engines and Boilers and their Management," says:

"There have been numerous methods tried with more or less success, for heating the feed-water, some by endeavoring to utilize the waste heat



OTIS FEED-WATER HEATER.

The exhaust steam enters and leaves at the top; the oil separator and settling chamber for sediment are at the bottom, away from the tubes, to prevent their stoppage by mud or scale. The tubes are suspended from the top to allow free expansion. The cold feed water enters at the bottom, near the center of the oil separator, with the purpose of chilling the oil which is drawn off through a drip pipe. Stewart Heater Co., Buffalo, N. Y.

in the funnel, others by means of steam direct from the boiler; and Weir's system, by using a portion of the steam in the low-pressure receiver. The latter method is generally considered to be the most efficient."

This system is the form of live-steam heater most commonly in use on shipboard, and it will be seen that it entirely differs from any attempt to take live-steam direct from the boiler. The steam is that which has already done work by expansion in the main engine, and is in position only to do a certain amount of further work of expansion from the pressure of the receiver from which it is taken. Where taken from the lower pressure cylinder, this steam, says Seaton, "might have been usefully employed in the low-pressure cylinder, but not to the full extent that it is in the heater, otherwise there would be no economy."

The steam thus withdrawn from a receiver has already done work in the preceding cylinders of the engine, so that the reduction of the work in the cylinder or cylinders from which it is diverted is compensated by additional work in the preceding cylinders.

The addition to the total volume supplied to the engine is therefore less than the amount withdrawn, in the proportion of the expansion it undergoes prior to its diversion.

Chart VIII. shows the proportion thus to be added to the total

supply for an amount withdrawn from any receiver of multi-cylinder engines, and the corresponding reduction of exhaust from the last cylinder which will accompany the process, on the basis of equal dynamic work in each cylinder. When steam is thus diverted from an engine to a contact heater, its total weight, and its heat at the reduced pressure, are conserved, and both are returnable to the boiler; while the work it has accomplished in the engine is to be credited against the initial supply. The foregoing combinations bring the temperature of the feed-water well above the boiling point, and if a higher degree of temperature should be desirable, it can be attained by used steam from the receiver, at higher pressure.

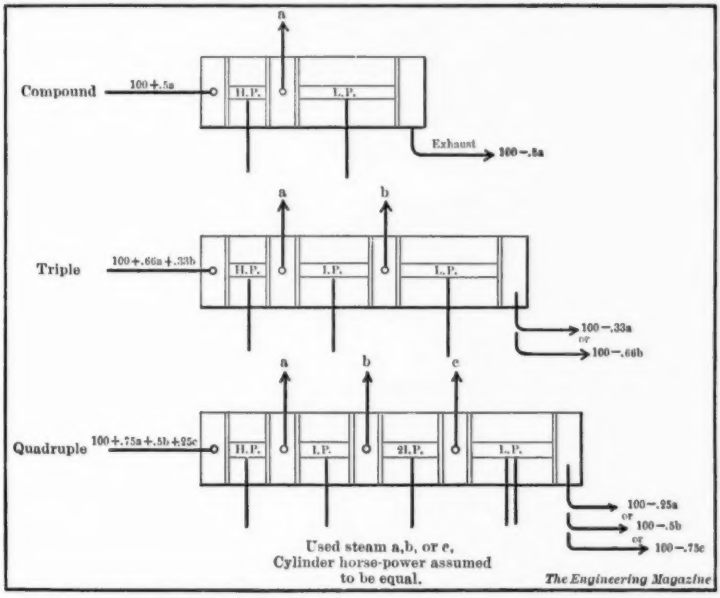


CHART VIII. PROPORTION ADDED TO SUPPLY OR TAKEN FROM EXHAUST BY STEAM USED FROM RECEIVERS OF MULTI-CYLINDER ENGINES.

The use of closed heaters would here be obligatory but the efficiency of such heaters may be increased as previously suggested by taking their drips to a coil in the hot well and discharging them at the resultant hot-well temperature.

The closed heater finds an economical adaptation on the exhaust of a condensing engine, in the form known as a "primary" heater. It is subject to the disadvantage of having all the cylinder oil carried

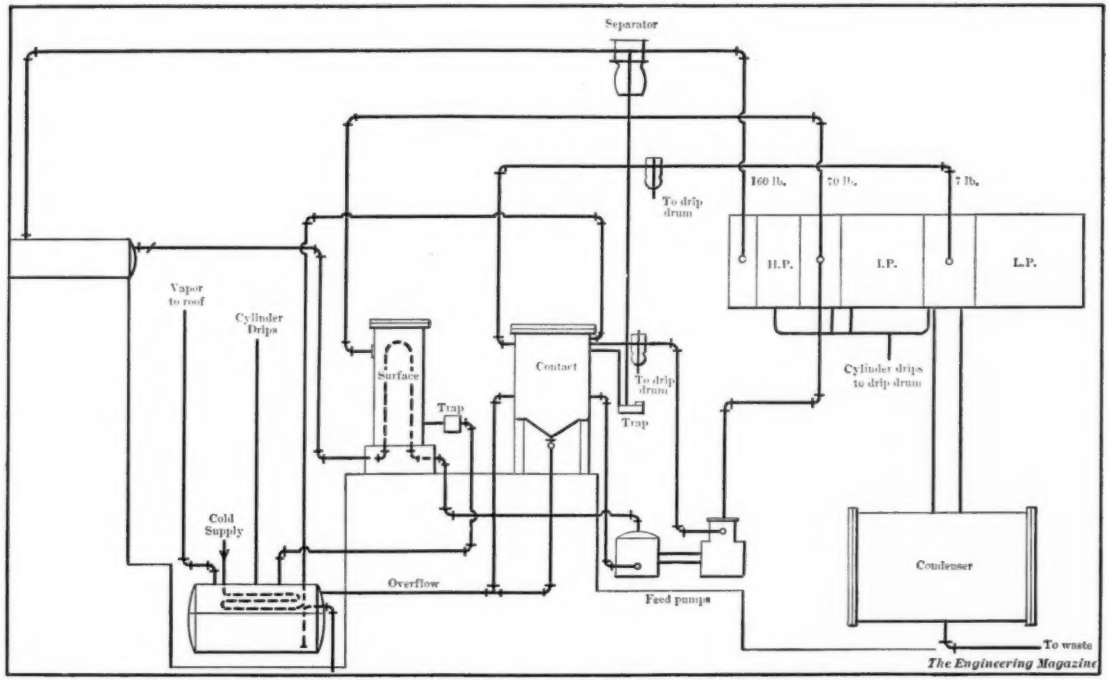
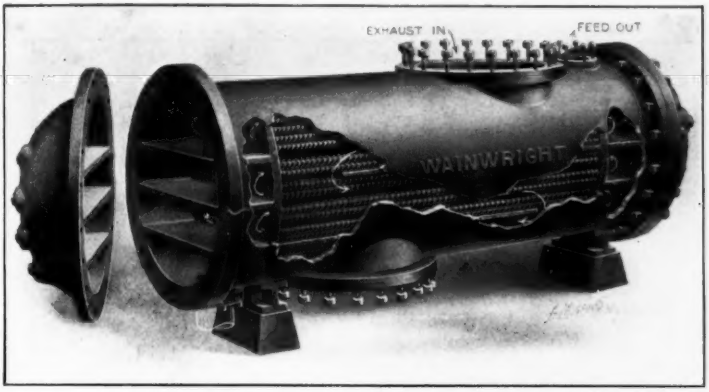


CHART IX. PROGRESSIVE FEED HEATING WITH CONDENSING ENGINE BY USED STEAM.



THE WAINWRIGHT EVENFLOW HEATER.

Secures the greatest possible temperature difference obtainable in a heater by counter-current effect, and the highest rate of absorption by rapid flow of water through corrugated tubes.

Alberger Condenser Co., New York.

over its surfaces, so that its efficiency is usually lowered after a period of use. It may be expected to raise the feed corresponding with the steam condensed only about 40 degrees, since the temperature of the closed or surface heater is only the mean between the temperature at the opening of the exhaust, and that of the interior of the condenser.

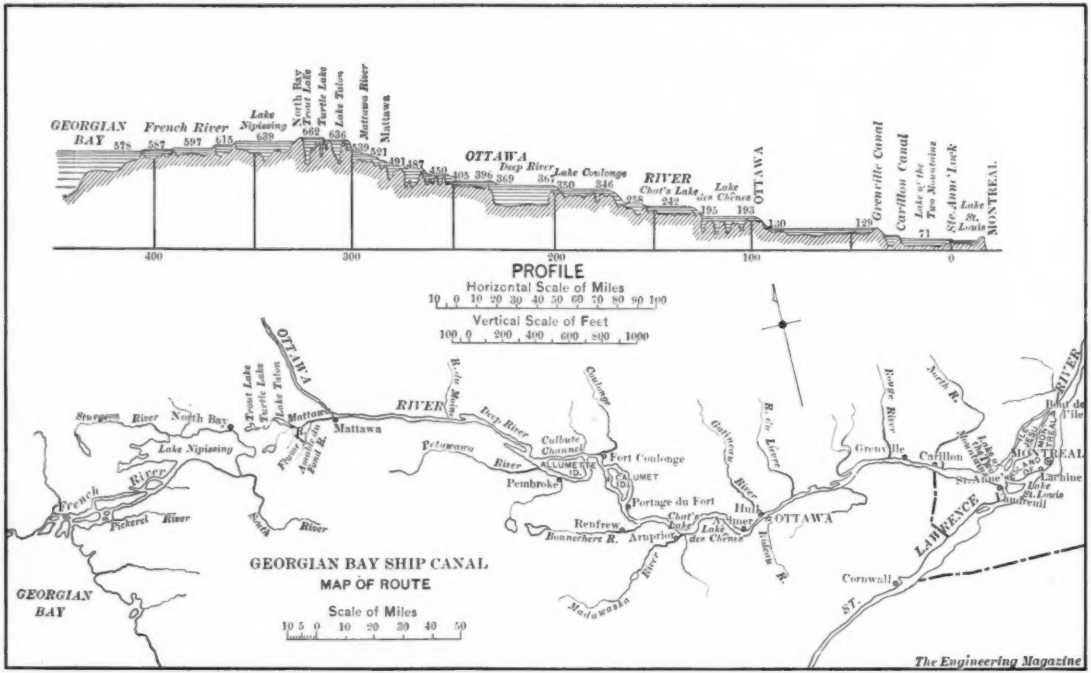
Summarizing the foregoing, we may conclude:

That the utilization of the heat in exhausted steam is a source of economy, up to the point where the amount will raise the temperature of the feed-water to 212 degrees F.

That in the absence of a sufficiency of waste heat, economical use may be made of the heat in partly expanded steam.

That the contact or open form of heater lends itself best to the utilization of the foregoing sources of heat retention, and may be usefully supplemented by the closed or surface form of heater in the process of prior heating of the supply, and also in adding to its temperature above the boiling point.

And we may well conclude the whole study, by the suggestion that the subject offers a fruitful field for the ingenuity and abilities of steam engineers.



PLAN AND PROFILE OF THE PROJECTED ROUTE OF THE GEORGIAN BAY SHIP CANAL.

THE GEORGIAN BAY SHIP CANAL.

By J. G. G. Kerry.

In a preceding article, published in our January issue, Mr. Kerry reviewed the history of the Georgian Bay Ship-Canal project and outlined the general features of the present plans for the waterway. In this concluding paper he treats in somewhat fuller detail the controlling problems of location and water-supply for the summit level, and discusses most interestingly the economic and financial elements of the proposition. His conclusion is that the undertaking is unquestionably wise in the interest of the expansion of agricultural, industrial, and mining activity throughout a great section of the Canadian West. Since the article was written, the Canadian Government has advertised for tenders for the first of the dams to control the waters of the Ottawa—one near the outlet of Lake Temiskaming. Mr. Kerry, it will be remembered, was a member of the Government commission which investigated the Quebec Bridge failure and a joint author of their very able report.—THE EDITORS.

IN the first half of this review of the Georgian Bay Ship Canal, which appeared in THE ENGINEERING MAGAZINE for January, the history and general outline of the project were summarized and some reference was made to the problem of providing sufficient water for the working of the summit level. Settlement and investment have rendered impracticable here the bold projects of the earlier engineers, and it is not now proposed to make any material change in the existing hydrography. The study of the engigeers has instead been directed to the estimation of the available water supply in the summit watershed and to the possible means of supplementing it. The district with its large forest areas, its severe climate and late spring, and its feeble evaporation, is well suited to a conservation of the natural rainfall and in this respect the location is most advantageous. It is intended to make a deep-water summit reach by flooding the series of small lakes, Trout, Talon and Turtle, that lie at the headwaters of the Mattawa River, and to design the summit locks so that this reach can be drawn down six feet below normal level without interference with navigation. It is estimated that the watershed tributary to these lakes will furnish a supply sufficient to allow 24 lockages to be made daily through the summit reach. This should be ample to handle all the traffic for many years to come, provided that some arrangement is made for an economical

locking of the smaller craft that are sure in season to throng such a waterway.

When the demand of the traffic is such that the existing watershed cannot provide for the lockages, the flow of the Amable du Fond River will be diverted into the summit reach. The Amable du Fond is a small stream lying to the south of the canal, and it is estimated that its discharge will more than double the supply available for the summit reach; at present it empties well to the eastward into the Mattawa waters. The generally unsettled and undeveloped condition of the district makes such a diversion possible without the legal conflicts and costly compensations that would be necessary in older countries.

The total lockage from the Georgian Bay up to the summit level is 99 feet and the lockage down to Montreal 659 feet, 27 locks in all being required if the Lake St. Louis location is adopted; the lock lifts will vary from 5 to 50 feet. As has already been stated the locks will be of the usual type, but unusual care has been taken to secure the most advantageous locations for them. The estimates are made for locks with chambers 650 by 65 by 22 feet, but the possibility of an increase both in length and width has been discussed. Where possible and as a measure both of safety and of economy the locks are placed in rock cuttings, and the character of the rock encountered is such that little more than a facing of the sides with concrete will be necessary. The locks will be provided with two pairs of steel gates at each end, so that the waters of the upper reach cannot break loose if by any accident a vessel should chance to run into one pair of gates. With modern power machinery there will be little difficulty in operating the two pairs of gates simultaneously. The locks are also by preference located so that the necessary water may be drawn directly from and discharged into the main river near the centre of the lock. All culverts and sluices and valves in the vicinity of the gates are avoided as far as possible. Guide piers for incoming vessels will be run far out on one side, and on the line of the lock, so as to avoid all difficulty at entrance. The rivers will provide abundant power for the lighting and working of the whole plant.

No provision has been made in the estimates for terminals at either end. The intention of the canal being to avoid transhipment until Montreal is reached, no provision other than a protection harbour is requisite at the western entrance; and at the eastern end there is already Montreal with its wharves, sheds, elevators, tracks, and machinery for handling bulk freight. Two routes have been surveyed

near Montreal, but if the teachings of history are to be regarded, the route by Lake St. Louis, which enables all existing facilities and the sites of the manufacturing and trading companies to be reached to the best advantage, will unquestionably be adopted. The Back River may subsequently be opened up to furnish facilities and accommodation for manufacturing concerns of great magnitude that may in the future desire to establish themselves near this commercial centre.

The canal location near Montreal is necessarily affected by the greater engineering problems of the city, of which perhaps the most important is the regulation of the St. Lawrence River, in the immediate vicinity, with the consequent increase of available power and the lessening of the floods and ice shoves which make the construction of terminal facilities in the harbour so costly an undertaking This problem was studied exhaustively in 1889 by the Montreal Flood Commission, of which Mr. T. C. Keefer was chairman, and a report was submitted. It was pointed out that the local difficulties arose almost entirely from enormous accumulations of "frasil" or "slush" ice, which was formed throughout the winter in the open waters of the Lachine Rapids. The remedy recommended was the creation, in so far as possible, of an ice cap over the water surface. If the construction of the Georgian Bay Ship Canal is undertaken by the Canadian Government it is hardly likely that so great an opportunity to carry out the ideas of the Flood Commission will be allowed to pass. If the regulation of the St. Lawrence River between Montreal Harbour and Lake St. Louis be successfully accomplished no canal construction near Montreal will be necessary and the available harbour frontage will be very greatly increased. This matter is not dealt with in the interim report, probably because the cost is not fairly chargeable to the canal scheme, but rather to the general development of Montreal as a commercial centre. Among the many problems suggested by or involved in the canal scheme there is probably not another equal in engineering interest or economic importance to this question of flooding out the Lachine Rapids, where the total fall of the river is about 50 feet, and the minimum flow nearly 250,000 cubic feet per second.

It should be noted that although this canal scheme calls for an expenditure (according to the latest estimates) of $100,000,000, it is to be regarded as a fairly simple piece of construction and as one that presents few problems that are not familiar to the profession. The works will be on a great scale, but there is no uncertainty about any

of major considerations connected with the execution of the work; and the estimates should be very close and accurate, for the surveys have been very carefully made and the unit cost of the various classes of work proposed is well-known. Compared to such problems as the enlargement of the Erie Canal or the building of the Panama, it is a model of simplicity and certainty. The lessons learned in the Detroit and St. Mary's Rivers make the adjustment of the design to the needs of the proposed traffic almost a piece of routine work.

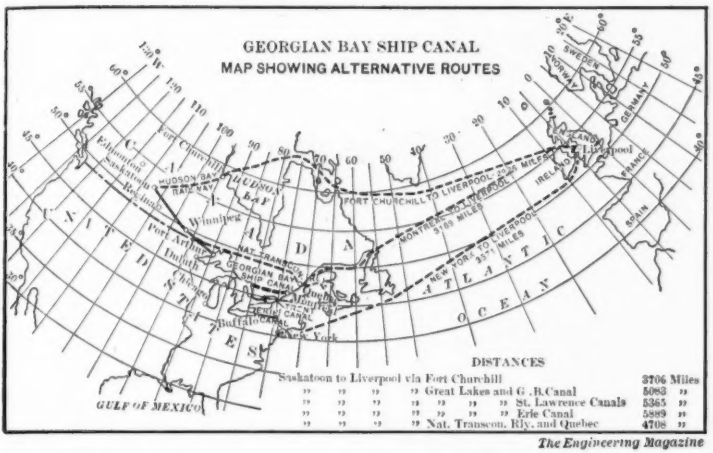
The real problem of the Georgian Bay Ship Canal is indeed not one of engineering, but of economics and finance. Will the improvement justify the outlay? This has been the question for fifty years past and it remains the question today.

In 1865, shortly after the publication of the Shanly & Clarke reports, Mr. William Kingsford, the Canadian historian, himself an engineer by training and occupation, wrote in his monograph on the Canadian Canals as follows: "The geographical situation of this navigation can only have in view the trade of Lake Michigan, for from the Lakes east of those waters the nearest route is by the St. Lawrence"; and "for purposes of Canadian navigation the canal is utterly unnecessary."

No one will now question the thoroughness of Mr. Kingsford's grasp of the situation or the soundness of his conclusion at the time of writing. The canal would then have served American traffic only.

In 1891, Mr. A. M. Wellington in his comments in *Engineering News,* practically endorsed Kingsford's opinion in the following words: "Had the route lain in American territory it would have been built long ago, and probably at Government expense as a free highway of commerce, so great is the opportunity. Were the route to-day under American control it would not be two years before work on it would be under way, but with one country to reap the chief gain and another country to pay the chief price for it, the prospect for any immediate action is poor." It may be said again that at the time of writing this conclusion was true.

The time has now come, however, when the Canadian publicist has ceased to look to the United States as the source of the traffic which his works are to handle. The growth of the settlement along the north shores of the Great Lakes, the rapidly increasing output of the prairie Provinces, and the diminishing importance of the United States as an exporter of heavy food stuffs, have combined to create conditions in his present which his predecessors could only predict for the far future. He realizes that England is still the great pur-



The Engineering Magazine

MAP SHOWING ALTERNATIVE ROUTES BETWEEN WESTERN CANADA AND EUROPE.

chasing market and that the returns to the Canadian farmer and shipper are determined by the prices ruling in Liverpool and London. Every reduction in the cost of transportation—and it should be remembered that it is a case of the transport of heavy material of low unit value over great distances—means therefore an increased price at the farm, and pending the growth of a local market, the Canadian West eagerly advocates every proposition that promises to reduce the cost of its export shipments. The West, however, has not been a very vehement advocate of the Georgian Bay Canal because the disability that is closest to it, and consequently most felt, has been the inability of the railroads to deliver its crops to the Great Lakes steamers at Fort William and Port Arthur before the close of navigation.

In my opinion there is little reason today why the West should advocate the construction of this waterway, for it is by no means clear that it would materially aid in the solution of the West's particular problem. The engineers in their report cannot find that the Georgian Bay Canal offers any advantages for grain shipments that cannot be obtained at a lesser cost by improving the St. Lawrence canals between Lake Erie and Montreal, and the climatic advantage of the St. Lawrence route has already been mentioned. Moreover, there are two great schemes, now more or less under way, to which the West looks with much interest and which affect it directly. The first of these is the National Transcontinental Railway, now building from Winnipeg to Quebec, with an east-bound grade of 0.4 per 100,

and a very direct route; and the second is the Hudson's Bay Railway, from Saskatoon to Fort Churchill, which is to tap each of the great grain-gathering railway systems and to deliver its traffic to the problematical navigation of the Hudson Bay and Hudson's Straits. This railway is now under survey. It may be reasonably predicted that the next few years will see the St. Lawrence route much improved, the National Transcontinental Railway in operation and the Hudson Bay Railway also. Each of these will take some share of the grain traffic, which in itself will not for many years to come be sufficiently great to justify the investment called for in the Georgian Bay scheme, even if all the export grain were carried by that route.

The engineers have based their design upon a probable traffic of 20,000,000 tons per annum, and when we bear in mind the history of the traffic passing Sault Ste. Marie there is little reason to question the estimate. Conditions are changing and settlement is advancing so rapidly towards the north that estimates based on the facts of today are a little less valuable than guesses of the traffic that will exist twenty years from now. I am a profound believer in the wisdom of constructing a Georgian Bay Canal, although not necessarily of the dimensions now planned, and this even though I do not think that the grain traffic from Western Canada will be a predominating item in the traffic returns of the canal. The work is necessary to the development of the region through which the canal is projected, and of the wealth and possibilities of that region we have abundant evidence. The Sault Ste. Marie traffic has grown on the coal and iron south of the Great Lakes at a rate beyond all prediction; but who knows what wealth lies to the north of those waters? Sudbury is not much over twenty years old, and its nickel-copper industry, now not half developed, is the result of an accident of railway location and was not in the minds of the men who built the Canadian Pacific Railway. Cobalt is not ten years old and might have lain unknown and undisturbed had not the Province of Ontario run a haphazard railway into the unopened north. Moose Mountain has not yet commenced to send out its iron, and no engineer will question the value of cheap transportation in the development of these mineral resources which come from surely only a few of the treasure spots in the unknown north. There is also the possibility of building up along the great valley with its water powers, its varied mineral deposits, and its wealth of timber, a manufacturing region unequalled on the continent. To this valley, which has raw material in such abundance tributary to it, cheap power and cheap transportation

are necessary, and with the advance in the demand for power for heavy manufacturing and the growth of the world demand for every staple, there seems little doubt that the Canadian people is economically justified in developing the Ottawa waterway. Its power supply will not be greatly in excess of the demand by the time that construction is complete, and the traffic of the Georgian Bay Canal, in my judgment, will be created mainly on or close to the canal and will be of a volume to justify its construction. Holding such opinions, it is waste of words for me to discuss the statistics of quantity, distance, and cost of operation, which would ordinarily be the determining factors in such an undertaking. It is not necessary that a great public improvement shall earn interest on its cost. Neither the Intercolonial Railway nor the Canadian Canal system have as yet ever done so, but the wisdom of building both these great works at public expense, in spite of all the minor errors of planning and administration, has never been questioned. They were essential to the welfare of the country that built them, and in a minor measure the same is true of the projected Georgian Bay Ship Canal.

THE NATURE AND CHARACTERISTICS OF THE NEW STEELS.

By O. M. Becker.

The literature of high-speed steel, in English, contains many excellent and useful articles relating to shop applications—many summaries, more or less empirical, of instructions for preparing and using alloy steel tools. There has been a marked deficiency, however, in the clear and comprehensive presentation of the whole range of knowledge on the subject—a lack of serviceable answers to the questions what are high-speed steels, how do they act, and why?

In this short series Mr. Becker addresses himself to this mode of treatment. The article here presented deals with the physical constitution of steels and the phenomena of tempering. A following paper next month will discuss in detail the influence and effect of all the ordinary alloy elements.—THE EDITORS.

UNTIL comparatively recent times the name "steel" was given by general consent to a combination of iron and carbon (as we now know), together usually with certain other substances present as impurities, such that when treated in a particular way the result was a material of high tensile strength, homogeneity, toughness, and ability to resist crumbling. The distinction between steel and some varieties of iron has been so slight that it is very difficult to make a definition which will include, even in the case of the carbon steels, all those iron alloys commonly designated steel, and which at the same time will exclude those of practically identical composition (though perhaps of different structure) which are admittedly *not* steel. It is, in fact, impossible to draw a sharp line between mild steel, produced in an open-hearth furnace, and iron made by the puddling or other process. The latter not infrequently has a higher carbon content than the mild steel. Before the development of the modern steel-making processes, it was comparatively easy to decide whether a given sample was steel or iron. If it hardened on being quenched in water after having been heated to a good red, and took a "temper," it was plainly steel. But mild steel, with its low content of carbon, does not take a temper any more than wrought iron does. With the advent of the newer steels still greater difficulties are in the way of a suitable and precise definition, and it would be hazardous to venture one here. It is sufficient for our purpose to take for granted that the name steel may properly be applied to any alloy of iron and the so-called hardening metals which is of such a structure as to permit hardening or tempering in such a way as to combine a

relatively high tensile strength, reluctance to fracture, and as said above, resistance to crumbling.

Since the discovery that substances other than carbon, in virtue of their presence give iron the quality of becoming hard and tough under certain treatment, it has become necessary to make distinctions among the various kinds of steels, and it is now customary to speak of them in a general way as carbon, Mushet or air-hardening, and high-speed or rapid steels, etc. Various other terms have been suggested but have not come into general use, though indeed the term "alloy steel" is commonly used to designate all steels other than those depending upon carbon chiefly for their specific qualities. The alloy steels in turn are frequently designated as vanadium steel, tungsten steel, and the like, according to the hardening alloy which predominates; and because tungsten was the first and still is the most common of the hardening metals used in the alloy steels, they are often spoken of as tungsten steels even though that element be in particular cases of minor importance or quite absent. Like carbon steel, the alloy steels are used for various purposes to which each is especially suited. Nickel steel, for instance, is largely used for armor plates and projectiles, and chrome and vanadium steel are largely used for the structural parts of machinery subjected to great strains, as in the case of certain automobile parts. It is not with this use of alloy steels however that we are at present concerned.

Ordinary carbon steel, such as has through the ages been used for tools, contains small proportions of elements other than iron and carbon. Some of these are useful and perhaps even necessary to make the steel easily workable, either in forging or melting. This is the case of silicon and manganese. Both tend to make steel sound by preventing the formation of blow holes. Silicon, in the quantities usually present in tool steels, has small, if any, effect upon the tool; though in steels for some other purposes, where the proportion of silicon may be larger, it causes stiffness and possibly also adds to the hardness. When present in excess of, say, 3 or 4 per cent, it causes brittleness and red-shortness. Manganese acts as a sort of antidote for sulphur, phosphorus, and perhaps other impurities found in steel. It prevents red-shortness, promotes the formation of fine and uniform crystallization, increases fluidity when the steel is melted, and makes it easy to work under the hammer or in rolls. Excess of manganese however makes steel cold-short (brittle when cold) and causes surface cracking, especially upon quenching.

Certain other elements, however, as phosphorus and sulphur, are not only useless, but distinctly harmful; and the greater the propor-

tion of either present, the more inferior the steel. Sulphur tends to make steel "red-short" (brittle at a red heat), and therefore difficult to forge; while phosphorus tends to make it "cold-short," and therefore brittle when cold. A very minute proportion of either will make a steel worthless for tools of almost any sort. Steel for cutting tools is usually expected to contain less than 0.02 per cent of either, though in some Mushet or air-hardening steel the sulphur and phosphorus content have each been found to exceed 0.05 per cent. In "extra special" grades both are kept below 0.008 per cent.

It will be seen that ordinary carbon tool steels, speaking in a general way, are constituted of iron, very small proportions of silicon and manganese in combination with carbon ranging from about 0.05 per cent to 1.5 per cent, and minute quantities of impurities such as phosphorus and sulphur. The variation possible in the carbon content of tools is well illustrated in the analyses of three well-known brands of carbon steel in use for lathe tools, whose performance was practically identical. The figures are quoted in part from Taylor. It is seen that the percentage of carbon varies from 0.681 to 1.240.

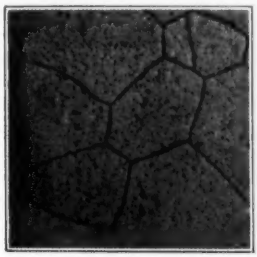
Steel.	Iron.	Manganese.	Silicon.	Sulphur.	Phosphorus.	Carbon.	Tungsten.
III & Z	98.524	0.189	0.206	0.017	0.017	1.047	
II	98.350	0.156	0.232	0.006	0.016	1.240	0.079
S	98.867	0.198	0.219	0.011	0.024	0.681	

Besides carbon, manganese, and silicon, self-hardening steel contains a considerable proportion of tungsten, chromium, molybdenum, vanadium, or certain other elements, generally in definite combinations, as shown hereafter. The silicon content is practically the same as in carbon steel, as also is the permissible amount of sulphur and phosphorus; but the carbon and manganese are much higher, the former running from 1.25 per cent to over 2 per cent, and the latter varying from rather more than 1 per cent to 3 or more, according as the tungsten content is high or low. Chromium, when present, takes the place of a portion of the manganese or the tungsten, which latter ranges from about 4 to 11 or 12 per cent. The analyses here given are characteristic of these steels:

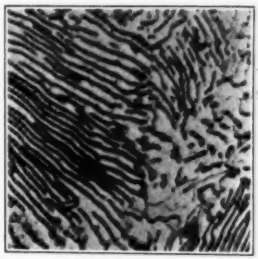
Steel	Carbon.	Tungsten.	Molybdenum.	Chromium.	Manganese.	Silicon.	Sulphur.	Phosphorus.
A.....	2.150	5.441	.....	0.398	1.578	1.044	.....	.....
B.....	1.615	.....	4.580	3.430	1.650	0.285	0.016	0.027
C.....	1.750	10.000	.....	1.000	1.750	0.060	.....	.....
D.....	1.812	11.580	.....	2.694	2.430	0.890	0.007	0.023
E.....	1.220	7.020	.....	0.078	0.300	0.180	0.010	0.0170

From the fact of its containing rather more than 7 per cent of tungsten, the steel marked E and separated from the other four

in the table would naturally be thought like the others, self-hardening. This however is not the case. Though it has a tungsten content about a half greater than that of some very good self-hardening steels, this steel has no such property, when heated to the customary temperatures, at any rate. It hardens only on being quenched in water, as is the case with ordinary carbon steel. This raises the question as to what causes tungsten steel to be self-hard, and why steel of any kind becomes hard under certain conditions.



FERRITE



PEARLITE.

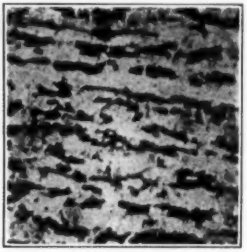
Both × 1,000. From Prof. H. C. H. Carpenter's paper before the Iron & Steel Institute.

The hardening of ordinary carbon steel, as is very well-known, is accomplished by heating the piece intended to be hardened to a red color ranging between a dark and bright cherry (something like 735 degrees C. or 1,350 degrees F.), and then quenching it in a water or other suitable bath to about the normal temperature of the air. This process seems to change entirely the structure of the steel as seen when examined under the microscope. Careful investigations into the nature of these changes have been made, and a number of theories or hypotheses have been advanced to account for or rather to explain them. The several hypotheses differ more or less among themselves; but those that are most generally received agree substantially that steel may exist, according to temperature or quenching temperature, in three type forms. At temperatures below 735 degrees C. or thereabouts carbon steel exists in the unhardened or annealed state. Between 735 degrees C. (1,350 degrees F.) and 820 degrees C. (1,510 degrees F.) it exists in a hardened state; and above 820 degrees C. it exists in a state harder than the first and softer than the second, and at the same time is very tough.

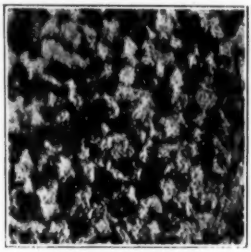
In the first or annealed state, corresponding approximately to the α steel of Osmond and others, carbon-iron steel is constituted of pearlite, or pearlite with cementite, or of pearlite with ferrite, according as the carbon content is at, above, or below 0.89 per cent.

Ferrite is iron free of carbon, and practically free of impurities. It is soft and forms substantially the whole of wrought iron and the greater portion of mild steel, both of which owe their essential characteristics to it. Cementite, on the other hand, is very hard, and also brittle. It is a carbide of iron, formed apparently in the presence of manganese and other elements found in steel, stated by some investigators to be of the chemical combination represented by the formula $Fe_3 C$. It is cementite that gives unhardened steel its stiffness, and at the same time tends to make it brittle.

Pearlite is an intimate mechanical mixture of cementite and ferrite, which forms the whole of unannealed carbon steel when it is saturated, or when the carbon content is just 0.89 per cent.*



PEARLITE (BLACK) SEGREGATED IN FERRITE.



CEMENTITE (BLACK) WITH CONTAINED PATCHES OF FERRITE.

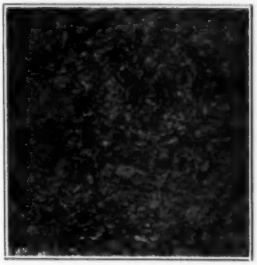
Prof. H. C. H. Carpenter. Both × 250.

Pearlite exists either as a crystalline mixture of the cementite and ferrite, or in a lamellar form in which exceedingly thin flakes or lamellae of cementite alternate with flakes of ferrite, giving a beautifully iridescent play of colors when viewed under the high powers of a microscope by the aid of oblique light. It is from this circumstance that pearlite has its name, because of its resemblance to mother-of-pearl in this play of colors. The lamellar form occurs in steel slowly cooled from above 735 degrees C., and the granular form usually is found in worked steel or steel re-heated to a low temperature.

As just pointed out, saturated steel at temperatures below 735 degrees C. consists wholly of pearlite. If a carbon content greater than 0.89 per cent be present, the excess of carbon crystallizes out as cementite; and if the percentage of carbon be lower, ferrite crystallizes out. In the first case (supersatuated or hypereutectoid steel)

* Professor J. O. Arnold, "Influence of Carbon on Iron."

the structure consists of pearlite and cementite; and in the second case (unsaturated or hypoeutectoid carbon content below 0.89 per cent) it consists of pearlite and ferrite. In the former case it is therefore more "steely" than in the latter.



MARTENSITE. (PROF. H. C. H. CARPENTER.)

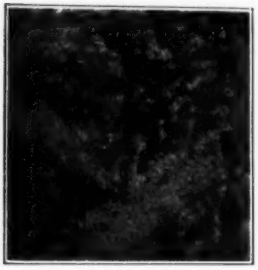
MARTENSITE AND CEMENTITE COMPLETELY SEPARATED.

The martensite is × 150 and the right-hand figure × 1,000.

Between the temperatures 735 degrees C. and 820 degrees C. (1,360 and 1,510 degrees F.) steel is very much harder and is in a state distinctly different from that just described. At about the point 735 degrees C. most of the cementite and ferrite which are mechanically combined in pearlite pass into a chemical compound, a very hard carbide, having, according to Arnold, the composition Fe_{24} C, which gives to hardened steel its essential characteristics. This intensely hard carbide, variously called hardenite or martensite, constitutes the whole of saturated steel. In unsaturated steel there is present, besides some indefinite portions of pearlite, cementite, and martensite, imperfectly segregated, also free ferrite, as in the first stage; while in supersaturated steel the martensite is accompanied by cementite. Martensite has already been stated to be much harder than the soft ferrite, which latter of course constitutes the greater or less proportion of steel according as the carbon content is high, (but still under) or low relatively to the saturation point, already stated to be 0.89 per cent of carbon content.

The higher the percentage of carbon, above the point of saturation, the greater the proportion of cementite formed. When present in excess, the cementite surrounds the crystals of martensite or hardenite with walls corresponding to the cell walls in living matter. Obviously, the greater the proportion of cementite, and therefore the thicker the walls surrounding the particles of martensite, the more brittle is the steel.

Above 820 degrees C. (1,510 degrees F.) hardened steel begins to lose some of its hardness; and at about 900 degrees C. (1,650 degrees F.) it has passed into a condition unlike either of the two already described, though it is not until a temperature of about 1,050 degrees has been reached that all the cementite disappears as such. In this state steel is neither so hard as in the second, nor so soft as in the first; but it is a great deal more tough, as already indicated. The change in structure and properties comes about through the solution of the ferrite or cementite, as the case may be, in the martensite; and the formation of a new structure called austenite,* which gives to steel the characteristics previously mentioned, of being harder than in the stage where ferrite predominates, and not so hard as in that where martensite or hardenite predominates.



AUSTENITE (× 900). PROF. H. C. CARPENTER.

It is well-known that if carbon steel is heated to a bright red, and even higher, and is then slowly cooled, it possesses little or no hardness; but if quickly plunged into water or oil, and thus cooled suddenly, it is hard, the degree of hardness depending for the most part upon the proportion of carbon in the steel. In the first case the steel has passed from the martensitic back to the pearlitic condition; in the latter the re-conversion into the normal or annealed condition is arrested in some way, and the steel remains in the martensitic state. If now the heating be carried well up, say above 820 and as far as 1,050 degrees C. (1,510 to 1,925 degrees F.) the point at which the steel has passed into the austentitic (γ or semi-hard) state, and is then slowly cooled, it passes successively into the martensitic and the pearlitic states again. If quenched, the result is still different from what might be expected in view of what happens

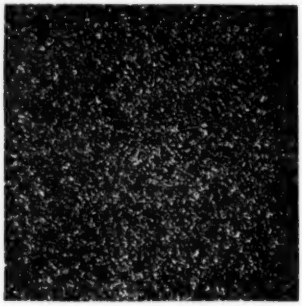
* Besides the ferrite, pearlite (in two forms—lamellar and granular), cementite, martensite or hardenite, and austenite, certain other forms, intermediate in reference to those named or very closely resembling some of them, are pretty well defined by metallurgists. Such for example, is troostite, which closely resembles martensite but is softer, and is plentifully found in steel as ordinarily hardened or tempered. Sorbite is a slight modification of pearlite, from which it differs by having a finer structure, the farthest removed from the crystalline yet found in steel. It is formed by rather rapid cooling (but not quenching) through the critical range, and is considered important in steels intended to resist wear and erosion. Certain alloy elements tend to promote its segregation naturally. In addition to these two variations from the regular structure of steel, some Continental writers speak of a still further modification of β iron, which they name hardenite, distinguishing it from martensite. Most often these two names are used to indicate the same formation, as is the case in this review.

when steel is quenched in the martensitic state. The steel comes out, not in the austenitic, but in the martensitic condition, and is in almost the same state as when quenched from the lower temperature. The austenitic condition did not remain. By microscopic examination, indeed, small particles of austenite can generally be found, mixed with martensite, cementite, or pearlite and ferrite, as the case may be; but the steel cannot in any sense be called austenitic. This condition is exceedingly difficult to "trap," to fix in a stable state so as to be characteristic in the cold metal. No matter how quickly a piece of steel may be quenched, even when plunged dazzling white into ice water, the change to the martensitic condition takes place still more quickly, and but a small amount of austentite will be found in it, so strong is the tendency to revert to the form characteristic of the lower temperature. Only in steel containing above 1.10 per cent of carbon is austenite to be obtained in any considerable proportion, and then only with difficulty.

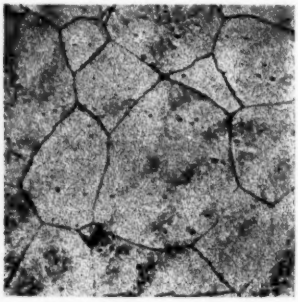
If steel could be retained in this austenitic or γ condition it would be not only hard enough, but strong or tough enough, for most purposes; though it would not indeed affect the speed qualities of the steel, as will be shown hereafter. Though the discoverers seem to attach little importance to the circumstance, the Taylor-White discoveries have proved (if indeed Mushet did not do so before) that this austenitic or γ state can be trapped, and is trapped in steels containing combinations of tungsten and certain other elements in addition to carbon—and that too without quenching.

The second or martensitic condition, that in which hardened carbon steel for the most part exists, is trapped with comparative ease. If steel be quenched in water, or any other suitable bath, while at any temperature above the first critical point, already given as about 735 degrees C. (1,360 F.), fixation takes place quickly enough to prevent a reversion to what may be called the basic or normal state, that in which pearlite predominates. This condition continues practically permanent unless the steel is again heated. If the temperature be raised to a point above that of quenching, and cooling subsequently takes place slowly, the steel is "let down" to the annealed condition, as if it had never been hardened. Much the same thing, in degree at any rate, takes place when a piece of hardened steel is heated to a temperature lower than that of quenching, but above, say 200 degrees C. (390 F.); and indeed in some cases it takes place to a slight extent without any heating. The tendency is for steel to return to the "normal," pearlitic, or annealed condition; and as the temperature is raised higher and higher, more and more of the hard or semi-hard carbides

are resolved into that less hard and more tough condition, which is requisite to tools of most kinds. This is just what takes place when tools are tempered after hardening. The "tempering," or "drawing" of the temper as the process is frequently called, consists merely in gradually heating a tool made of steel of a known quality to a temperature shown by experience to be most suitable for obtaining the desired degree of hardness or toughness.



TYPICAL STRUCTURE OF ANNEALED STEELS. 150 DIAMETERS.



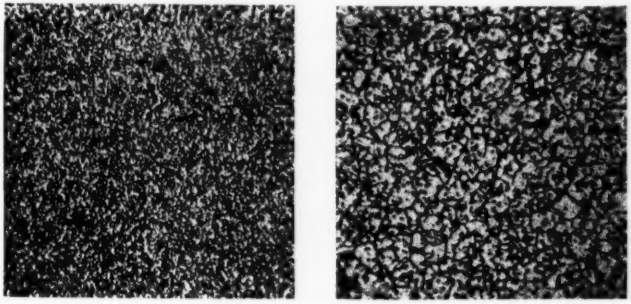
STRUCTURE OF HARDENED HIGH-SPEED STEEL. 1,000 DIAMETERS.

The photographic reproductions on this page and the pages following are taken by permission from Mr. C. A. Edwards' paper on The Function of Chromium and Tungsten in High-Speed Steel, in the Journal of the Iron & Steel Institute.

In carbon steels of ordinary composition the softening begins, as just indicated, at about 200 degrees C. (390 F.), at which point the polished surface begins to assume a slight straw color; it continues through a range of about 170 degrees C., passing through the well-known color scale generally given as faint yellow, straw, dark straw, purple, dark purple, deep blue, dark blue, sea green and black. At this point, about 370 degrees C. (700 F.), carbon steel has lost all its hardness. The temper-resisting quality of high-speed steel, its so-called red-hardness, is indicated in this: that softening does not begin much, if any, below 550 degrees C. (1,020 F.), and it is not completed until a temperature close to 700 degrees C. (1,300 F.) is reached. At this point the steel is already quite red, though considerably short of the bright cherry red so much used as a standard of reference. In some high-speed steels considerable hardness remains even at this temperature.

The "critical points," the temperatures at which or within which these important chemical and structural changes take place, have been given above approximately only. The fact is, it is not possible to state them with absolute precision, not only because of the diffi-

culty of making accurate observations with the instruments at hand; but because they vary more or less according to conditions. There is, for instance, a variation governed by the percentage of carbon present. Also, there are in low-carbon steel, say below 0.3 per cent., not one, but three rather well defined critical points near 700 degrees C., which in steel of higher carbon content merge into one another so as to be indistinguishable. The presence of tungsten and manganese, and certain other substances also, in a steel likewise affect the transformation points, the critical temperature being lowered approximately in proportion to the alloy present. In the case of chromium, singularly enough, the tendency is the other way, and the critical points are likely to be lower in consequence of the presence of this element than without it. Furthermore, the transformation points are not the same for cooling as for heating, the latter being somewhere between 30 and 100 degrees C. (in high speed steel generally near 100) higher than the former. The change which takes place in cooling, it has been shown, cannot occur until the steel has first been heated above the point where it takes place in heating; so that in treating tools it is necessary to consider only the rising critical point, that at which the change occurs in heating. Inasmuch as the changes do not take place instantaneously, but on the contrary rather slowly, the steel must be held at a temperature somewhat above the desired critical point for a longer or shorter time as may be necessary to insure complete conversion.

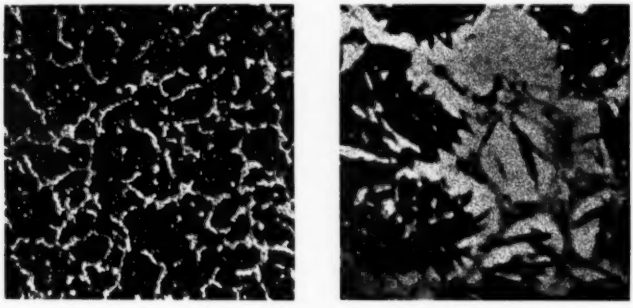


TYPICAL OF ALL ALLOYS CONTAINING MORE THAN 9.0 PER CENT TUNGSTEN AND 3.0 PER CENT CHROMIUM.

On the left, 150 diameters; on the right, 1,000 diameters.

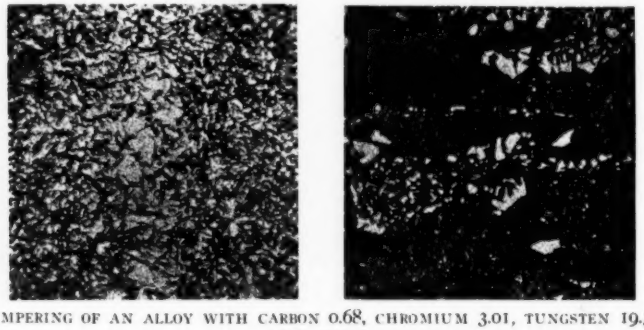
The transformation points are accompanied by a singular phenomenon by which they are identified with comparative ease, and from which they are sometimes called "points of recalescence." The most marked one, observable in practically all steels, is that which

occurs when the pearlitic structure is transformed into the martensitic. A piece of steel placed in a furnace whose temperature is kept constant at a very high point, absorbs heat at a rather uniform rate which very gradually diminishes in a geometrical proportion, approximately, until a temperature in the neighborhood of 700 degrees C. (1,300 F.) is reached. Here a singular thing take place. Instead of rising in temperature as before, the steel for a short time (from half



TEMPERING OF AN ALLOY WITH CARBON 0.67, CHROMIUM 6.18, TUNGSTEN 12.5 PER CENT.

On the left, heated to 730 degrees C.; 150 diameters. On the right, heated to 730 degrees C.; 1,000 diameters.



TEMPERING OF AN ALLOY WITH CARBON 0.68, CHROMIUM 3.01, TUNGSTEN 19.37 PER CENT.

On the left, heated to 680 degrees C.; 1,000 diameters. On the right, heated to 730 degrees C.; 1,000 diameters. The changes of structure are not so rapid as in (A).

a minute to ten minutes or more, according to circumstances) rises in temperature very slowly compared with the former rate, remains quite stationary, or in some cases even falls slightly, in certain steels as much as 30 degrees. Evidently some important molecular change is going on within the steel, which is absorbing enough heat to retard or stop entirely the rise in temperature; and this change doubtless is the transformation of pearlite and its concomitants into martensite.

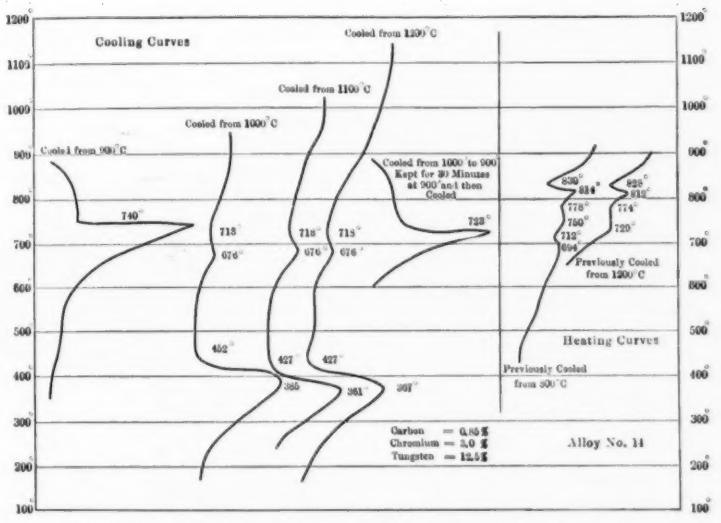


CHART SHOWING CLEARLY THE LOWER CRITICAL POINT—THAT CONNECTED WITH THE PHENOMENA OF TEMPERING.

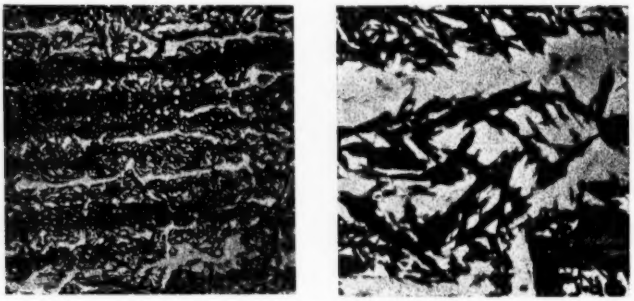
Movements of the differential galvanometer, about 1/25 size. Prof. H. C. H. Carpenter before the Iron and Steel Institute.

A somewhat similar phenomenon has been observed in the case of certain metals when the crystalline (solid) structure is changed to a fluid, at the melting point.

Singularly enough when the steel is cooling the reverse change does not occur at the same point as when heating, but, as might be surmised from the statement above, the transformation points for cooling and heating are not the same. The curves of the recording pyrometer show that the retardation or stationary point for cooling is something like a hundred degrees C. lower than that for heating; and that there is no such point of recalescence, as it is sometimes called, unless the steel has been first heated above the recalescence or critical point some hundred degrees above.

In high-speed steel the curve for heating is much more uniform than in the case of carbon steels, there usually being but a slight variation at the critical point. The cooling curve, while still much more regular than that for carbon steel, is yet considerably more marked than the heating curve.

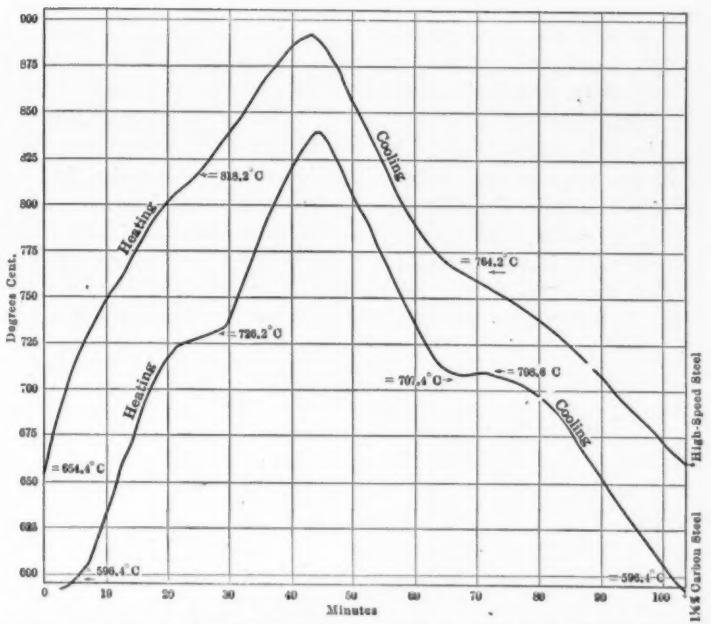
The deviations in the curves also occur, for the most part, at temperatures considerably lower than in carbon steels. Especially is this true of the transformation point between pearlite and martensite, that is, between the hard and the soft or annealed state.



STRUCTURE OF THE NOSE OF A HIGH-SPEED TOOL AFTER CUTTING AT ITS MAXIMUM SPEED FOR 20 MINUTES.

On the left, 150 diameters; on the right, 1,000 diameters. Long white austenitic streaks embedded in a martensitic structure.

It is through this lowering of the transformation point to such an extent that the martensitic structure continues unchanged until it has become "fixed," that is, has reached the temperature where this structure no longer tends to change into the soft pearlitic or annealed, that steels become self-hard, and do not require quenching. This lowering of the transformation point is due to the presence of tungsten and manganese or chromium, or the like combination of the steel-hardening substances (vanadium excepted); and it is approximately in proportion to the amount of alloy contained. In the case of some of these alloy materials, especially of those most used in high-speed steel because of their cheapness or the qualities they impart, this tendency to lower the critical point or range, high as well as middle and low, becomes active only when they are combined with certain others in more or less definite proportions. Thus tungsten, to which the most important part in giving high-speed steel its peculiar properties has been until recently attributed, does not at moderate temperatures at any rate, lower the transformation points much, if at all; and neither does molybdenum. If, however, these are combined with chromium or manganese, and possibly to a slight extent with certain other substances, this lowering takes place; and when these elements are present in such proportion that the tendency of the steel to revert from the austenitic (γ or medium hard and tough) condition to the martensitic (β or hardenitic, which is the very hard state) condition is counteracted until the temperature has passed below the point where this change can take place; then the structure of the steel becomes fixed or permanent in that condition, and the steel is austenitic, or high-speed, and that without quenching. Precisely the same thing in respect of the change to the pearlitic (soft) state, takes



CURVES SHOWING RELATIVE LOCATION AND NATURE OF CRITICAL RANGES IN CARBON AND HIGH-SPEED STEEL.

The lower position of the cooling recalescence range, compared with the heating range, is also shown.

place when the alloy steel is heated to the temperature at which the martensitic form occurs. The combination of alloys retards the change from one condition to the other, entangles the martensitic structure as it were, until the temperature has become lower than the point at which the change can take place. The steel is then also self-hard without quenching; but is in the martensitic or very hard state, and does not have the high-speed properties to any considerable extent, if at all.

Now the old Mushet or self-hardening steels were alloys in which the above changes took place in the manner indicated. The tungsten, in the presence of a sufficient proportion of manganese (or in some cases, of chromium) prevented the change from the martensitic to the pearlitic structure until that condition had become fixed or permanent through normal cooling or cooling in an air blast, quenching being therefore unnecessary. Since however the temper-resisting properties of tungsten steels are for the most part found when it is in the austenitic or γ state; and since this state occurs only when

the steel is heated to a white heat, above say 820 and up to near 1,050 degrees C. (a temperature to which the Mushet steels were rarely or never raised); and then only when the percentage of alloy is very high, much higher than was found in the old self-hardening steels: it is evident that the Mushet steels lacked in those very things which are characteristic of modern high-speed steels and which were discovered or developed by Mr. Taylor and his associates.

The anomaly exhibited by the last steel mentioned in the table on page 802 is now explained. Even though it contains a relatively high percentage of tungsten, rather more than 7 per cent, it will be seen by referring to the table that it contains but 0.3 per cent of manganese, and but little more than a trace of chromium. Though there is ample tungsten to make the steel self-hard, it is not combined with a sufficient amount of manganese or chromium.

Not all the hardening elements act in the same way to produce the effects here described, though with the exception of carbon and vanadium their action is more or less like that of tungsten—or perhaps it were better to say like nickel and manganese, which latter two may be taken as typical from the circumstance that they alone, as it would seem, act directly to lower the transformation or critical points in steel normally and without noticeable complicating phenomena. Molybdenum also behaves in almost the same way, very closely resembling tungsten in its influence. Both tungsten and molybdenum form with carbon, even when there is but an infinitesimal amount of the latter present, certain soft and brittle carbides whose presence in steel tends to make it worthless for tool purposes. The transformation points, already described, are not lowered materially unless the steel has been first raised to a very high temperature, close to 1,200 degrees C. (2,200 F.), and the double carbides destroyed. If the molybdenum or tungsten is low, the steel is then martensitic, self-hardening, and very much like Mushet steel; and if high, it is austenitic, air-hardening, and to a greater or less extent high-speed.

EFFICIENCY AS A BASIS FOR OPERATION AND WAGES.

By Harrington Emerson.

VIII. THE EFFICIENCY SYSTEM IN OPERATION.

The parts of Mr. Emerson's series, which began in our issue for July last, already presented have discussed the world-wide evils of inefficiency in almost every branch of human activity; the peculiar national qualities which have thus far helped the leading industrial nations to mitigate the losses due to inefficiency; the necessity for supplementing the line system of organization on which industrial management principally depends with modern staff organization; the relation of standards to organization and to results; and the realization of standards in practice. In the December and January installments he reached the "modern theory of cost accounting," which in his view requires that actual costs must be subdivided into standard costs and preventable wastes; that standard costs must be based on full equivalency in service rendered for money spent; that standard costs must always be predetermined; that average wastes are part of general expense and can be currently anticipated; that the chief duty of the operator is the maintenance of all standards; and that cost standards can only be attained through methods, records, ideals and checks furnished jointly by the comptroller and the efficiency engineer to the executive line officials.—THE EDITORS.

IN the last essay the method of reconciling predetermined allotted costs with actual expenses was outlined as to a real case, in which efficiency methods reduced unit costs from $0.1031 to $0.048, effecting a saving of $345,933.*

The reduction of cost is an efficiency result compared to which the method of stating it in the accounts would be unimportant, were it not that the ability to follow efficiency methods and to convince others of their value and effect depends largely on clear and easily understood statements, and these statements are difficult to obtain and do not carry weight unless at some point they are certified by the accountants, and thus tied into the official expense reports. Efficiency records and accounting records can coincide only at one point—namely, where the same equivalents are used. All the expenses of the year appertaining to a unit, divided by all the units for the year, can be used by both efficiency engineer and by accountant, but in this case no statement of efficiency and expense will coincide for a shorter period or for a smaller number of units. If at the other end—the single unit for the smallest time—cost-accountant and efficiency engi-

* For reference, this table is repeated in simpler form on the next page, and errors which escaped the proof reader are corrected.

ALLOTTED AND ACTUAL COSTS AND THEIR RECONCILIATION.

	1903-4.	1904-5.	1905-6.	1906-7.
Total units	4,725,000	4,785,400	5,776,000	6,462,800
Allotted unit standard costs	$0.06	$0.06	$0.06	$0.05
Allotted unit wastes	0.04	0.04	0.01	....
Allotted total unit costs	$0.10	$0.10	$0.07	$0.05
Actual unit costs	0.1031	0.1017	0.065	0.048
Allotted standard costs	$283,500	$287,124	$346,560	$323,140
Allotted wastes	189,000	191,416	57,760	.....
Allotted total costs	$472,500	$478,540	$404,320	$323,140
Actual costs from President's annual report	487,171	486,620	376,106	315.844
Credit to Efficiency account	.....	.....	$28,214	$7,296
Debit to Efficiency account	$14,671	$8,080	.....	.....
Credit carried from preceding year	.....	.....	.....	$5,463
Debit carried from preceding year	.....	$14,671	$22,751	.....
Credit to carry to following year	.....	.....	$5,463	$12,759
Debit to carry to following year	$14,671	$22,751	.....	.....

neer agree as to a method of stating cost for the single unit of work, then the records built up from this base will diverge immediately, as efficiency corrections are not identical with expense corrections. It is however very important that both efficiency statements and cost statements keep close together, that both should use the same unit, that both should use equivalency (standard cost) and that expense shall be stated in two terms: Standard Cost and Waste. It will prove convenient for the accountant to standardize from previous records both the current percentage of waste and the general burden resulting from indirect expense, rather than to carry into the daily operative expense statement the actual but partly accidental waste and the actual fluctuating burden, especially as the standardization of waste permits a very close prestatement of cost which is always of advantage and also brings back forcibly to the accountant the great purpose for which accounts were originally evolved and developed—namely, to locate and eliminate wastes. Whether efficiency records receive the assistance of accounting statements or not, the methods of attaining efficiency are as follows:

The volume of work to be done is carefully measured or estimated in advance on a unit basis.

In preparing to build a line of railway today the tons of rails, the number of ties on the mileage basis, the quantity of earth and rock

handled on a cubic-yard basis, are easily predetermined. Predetermination was not always resorted to in the early days, and there is a story current that after the first trans-continental road was built the number of ties actually under the rails was only half the number that had been paid for. From the stories told me by eye-witnesses of and participants in the methods of counting ties delivered I am surprised that the final result was so good. It would have been just as easy to have estimated "ties required" in advance, to have accepted no more than enough, and to have paid only for those under the track, in fact, to have counted first and have paid afterwards, instead of paying first and counting afterwards. Similarly it is possible as to any operating road to estimate in advance and in detail the reasonable unit cost of each item of repair and also the reasonable number of each kind of units. The number of some units may increase, owing to unforseeable causes; but as units increase, cost per unit should go down, offsetting to some degree the accidental increase. When a careful pre-estimate is made of the reasonable cost of the great items of operative cost on a railroad it is found that they are not infrequently less than half the actual cost, and I do not know of any important railroad within the limits of the United States in which the locomotive repair cost of $0.06 per mile ought not to be ample, instead of the $0.08, $0.10, $0.12 calmly embodied in annual reports.

The cost of ties for a new railroad depends less on the number required than on the cost of each, since even the grossest waste of supply can scarcely double the quantity; but there is almost no limit to the amount which corruption and similar carelessness may pay for individual items, as has been recently well illustrated in the State House furnishing scandals of Pennsylvania. So also in manufacturing operation. While the volume of business has an important bearing on cost, it is not as important as the unit cost of operation which need not be appreciably more for a few operations than for many. It is the methods used to secure control of unit cost which are important, little known and rarely used. The cost of any operation consists of four items:

1.—Material used

2.—Labor service used

3.—Equipment service used

4.—Indirect expense, carried partly in 3 and partly as a burden on all labor service used.

Items 2, 3 and 4 can be combined in a single "service" requisition. Item (1) is covered by a "material" requisition.

Two forms of requisition are therefore sufficient to cover every possible item of operation expenses, of cost, of accounting and of efficiency, and, except as to form, there is no difference between a material expense order and a service expense order.

The best basis for a cost and efficiency system is: Not to issue any material without a full requisition, not to permit any work to be done without a service order.

Stores Issued To Department		State Use For	
ITEM	DESCRIPTION	ACCOUNT Entries to be by storekeeper	CHARGE
QUANTITY	QUALITY	COST PER $	TOTAL VALUE $

Storekeeper please issue above material	Month	Day	Year
			190

To_____
(Give Name. Do not make out to bearer)

Approved by_____ Foreman
(Values to be filled in at storehouse)

Issued by_____ Entries made by_____

(Name of Plant)

The Engineering Magazine

FORM I. MATERIAL REQUISITION. THE ORIGINAL IS 5 INCHES WIDE.

Figures 1 and 2 illustrate the two forms of requisition. Nearly all operating concerns realize the importance of these fundamental records which provide both material and service cards, but it has been my experience to find them curiously incomplete, therefore largely without value and in consequence neglected and distrustfully used. They are supplemented and obscured in a mass of independent and confusing records and forms, which are superfluous since all the information is more exactly contained and in more potentially available form in the original requisitions. Virtually the whole of efficient management can flow from an able superintendent making proper use of complete requisitions. The objection to full requisitions lies partly in the inherent objection of almost everybody to exactness and precision and partly in the panicky fear of managers that their use will increase "indirect expense" for clerical help. It is however a fact that the same amount of tabulated information will cost less if based on and built up from these requisitions than if secured along independent lines.

Industrial shops could well learn from other concerns as banks or restaurants which use similar requisitions effectually. A club restaurant finds it expedient to exact from each guest a minute written requisition in duplicate, signed and dated, for the meal he orders. If the requisition is paid in cash on delivery of the supplies it becomes the voucher in the cashier's hands, but if charged it is carried to the account of the individual and becomes the voucher for his bill. The duplicate goes to the kitchen and becomes the kitchen's record of portions served. A third copy should go to the commissary department and there be analyzed and tabulated so as to know and check whether 100 pounds of purchased turkey resulted in 200 portions or in only 150. If a restaurant is able to obtain original requisitions in this manner in the rush of the noon hour, virtually without expense, an industrial plant can very much more afford to do the same thing. It is obviously very much better for a foreman to think one minute and write on a requisition "Give to John Doe one lead pencil No. 3, and do not give him another for a month," than it is to write in 30 seconds, "Give bearer all the pencils he wants." The careless method apparently saves 30 seconds, costing $0.005 of the foreman's or the foreman's clerk's valuable time, but it results in $0.10 to $0.20 extra expense for pencils.

MATERIAL REQUISITION.

No material, whether lead pencil to clerk, or steamer-load of coal to power house, should be supplied except on requisition, and this should state the use to which the material is to be put, and specify the amount, kind and quality. As every material issue should be standardized, the moment the standard is exceeded (as for instance lead pencils to a given clerk) reproof comes back to the foreman and to the individual before the requisition is twenty-four hours old. It is no more legitimate to overissue material, even a lead pencil, without inquiry, than it is for a bank to pay an overdraft check without proper consideration and authority. The material requisition cards, containing as they do, very full data, should be sorted and resorted in many ways, being used as checks on individuals or on foremen, against departments, against operation, or against accounts. The use made of the requisition cards is a special department of management. The extreme of simplicity is to charge the requisitions against certain accounts, then to sort and file them away and use them only for special investigations. If for instance the question is asked why there are so many incandescent lamps purchased, it is immediately possible to collect the requisitions for all the incandescent lamps issued to each department, even to each socket, and to trace the exact point

of leak or waste, due rarely to the inevitable, generally to carelessness and sometimes to dishonesty. The extreme of completeness is to transfer by means of perforation all the requisition facts as fast as they are filled to a Hollerith card, to run the sorting and tabulating machine at night, and to present a complete tabulated array of cost and efficiency facts before operations begin the following day.

SERVICE CARD

Workman's Name			Plant and Department			
Mans No.		Machine No.		Dept. #		
Mans Rate		Machine Rate		Hourly Cost		
Date	Schedule	Account	Charge	Standard Time	Actual Time	Efficiency

Time Started	
Time Finished	
Elapsed Time	

OPERATION

Foreman

The Engineering Magazine

FORM 2. SERVICE REQUISITION. THE ORIGINAL IS 5 INCHES WIDE.

WORK OR SERVICE REQUISITION CARDS.

These are issued and used in the same manner as the material cards. No work is undertaken, whether by individual or gang, except on order. The order contains all the data and when returned records the exact time taken for the operation. The cards therefore cover the whole of every workers' or gangs' time in minute detail and as to the kind and volume of work done in equivalency for the time and wages. The minutes and hours are accurately accounted for in proper sequence. All the time of every man or gang, subdivided to operations, being available, it is easy to use the records in many ways. In practice the original order card or service requisition can be made out in three or more carbon copies. The original order starts from the dispatching board, which is prepared with spaces 4 inches by 10 inches for each man, machine, or gang of men. The space is large enough to hold three cards one above the other. The uppermost space shows the job on which work at the moment is being done, the space below contains the cards of the work to be next taken up, and the last space contains the amount of work impending but not yet ready. The dispatcher, in charge of the board, who may work in conjunc-

tion with the foreman, sees to it that the first two spaces are always provided with order cards. If the two lower spaces are both bare the worker should be laid off, or if he is retained in idleness his time should be charged to a waste account.

The efficiency engineer or his subordinates will note on every card, preferably before it goes to the worker, the standard time for the operation determined as accurately as current circumstances will permit, so that both the actual time and the standard time become part of the record. A guess as to standard time is a great advance over no recorded statement, but a guess is unpardonable, except for an emergency and until reliable methods are provided. Whether first record card or carbon duplicates are used, whether the original record cards are transferred to Hollerith cards, is immaterial. It is of importance that every kind of information and efficiency as to every man and every part of his work become available, and more than this is not needed to show where leaks occur. A few uses of the cards in this regard will be enumerated.

COST ACCOUNTING.

The card contains the standard time, the cost for standard time of men, equipment, and department per hour, also the operation and the account to which the time is charged. It also contains the actual time and it is therefore in itself an efficiency record. The cost accountant can either charge up the standard cost adding the current departmental percentage of inefficiency, or he can charge up the standard cost and the actual accidental waste. If the records given him are carbon duplicates he can file them away as vouchers.

STANDARD COST OF SCHEDULES.

A schedule is the numbered description of an operation. If an operation is often repeated a schedule is formally and most carefully made out, but if the operation is a new one or one not likely to be repeated the same amount of care is not taken to fix the standard time, although any inaccurate estimates as to this time are easily traced to the man who made them. Every time a schedule is put in operation a carbon duplicate of the service card is filed under the head of the schedule, and a study of the repeated operations of the same schedule shows whether it averages more or less than standard time and cost, whether the different men take more or less time, whether the same man takes more or less time on different days. These variations are a mine of information for departmental improvement.

EFFICIENCY OF MEN.

When the service card is returned and the actual time noted on it or on a carbon copy it is filed against the worker and makes any other

record of his going or coming unnecessary. In a working month of 250 hours the cards will show whether a worker was present all or only part of the time—thus determining the efficiency of presence or availability; the summation of the standard hours of work delivered and the actual hours taken during a pay period shows the efficiency of each man, while cash job record shows the efficiency as to every separate job. If a worker in 250 hours delivers 250 hours of standard work his efficiency is 100 per cent; if he delivers only 200 standard hours his efficiency is 80 per cent, and if he delivers 300 standard hours his efficiency is 120 per cent. When records of this kind are maintained the efficient men as to steadiness and output loom up like mountains from a plain and the inefficient appear like sink-holes. If the efficient men are appreciated and rewarded at their true value, if the inefficient are allowed automatically to eliminate themselves, an *esprit de corps* is developed that will make the working shop force as active and powerful an aggregation as a football or baseball team. Excellence is not gauged by any hustle and drive standards. In railroad operation the trains that pass between distant terminals in the shortest time are not those that run the fastest between local stations, but they nevertheless cost less to operate, they give less trouble to the dispatcher, they are not as destructive to motive power, equipment, and roadbed, they use less coal and water, and they earn generally per mile run the highest revenue. Similarly that shop works at highest efficiency which steadily employs steady and reliable men.

EQUIPMENT OPERATION.

The unit cards, whether the original or carbon duplicate be used, give a complete record of the operation of the equipment, showing the machine, its number, rate, the man using it, the work done on it, and the time taken. It is possible from the records to compare the time and cost of different machines on the same work, the total time that any machine is working. The equipment specialist scans the records and he will not be satisfied if a worker operates one machine for six hours at 100 per cent efficiency and then for four hours another machine at 100 per cent efficiency. This is no better than if a furnace runs continuously under a boiler while the fireman sits idle half the time. The equipment specialist is concerned that one machine owing to idleness operates at 60 per cent and the other, for the same cause, at only 40 per cent. It is often possible to combine the work of two machines on one and dispense with the other. It is even more likely unnecessary purchases of equipment will be avoided.

It is impossible briefly to describe all the methods to secure a reasonable standard time for a unit operation, whether of man, or ma-

chine, of gang, or as to an aggregate group of operations extending over the whole plant, as the completion of an order for fifty locomotives or the running of twenty trains a day during a month over a road. Whether the unit or the aggregate is under consideration the methods of the analytical chemist prevail, each detail is considered separately, both as to itself and in its relation to preceding and subsequent details. Studies of this kind reveal remarkable inefficiency in usual operations. When all the conditions were made exactly right, bricks have been laid in a rough wall at the rate of twenty a minute, and ¾-inch rivets have been driven with a pneumatic gun in structural iron work also at the rate of twenty a minute. Owing to the perfect adaptation of conditions the operator found his work no more exhausting than the usual pace. This rate cannot be maintained for a long period because attending conditions cannot be kept up to the ability of the man, but a very high average rate can be maintained day in and day out and the worker thrive under it both physically and financially.

Constant reference has been made to the extra reward paid to men, for high efficiency. There are many methods of rewarding efficiency, and several of them are outlined in THE ENGINEERING MAGAZINE for November (Carl Bender). The standard-time determination usually shows that fully 50 per cent more work can be turned out per machine and per man if all the methods, machines and men are toned up. A satisfactory way of toning up the men and securing their co-operation is to offer them an increasing bonus on their wages for increasing efficiency. Assuming the current output of the shop to be on a basis of 67 per cent, a bonus is paid for any improvement above 67 per cent. At 100 per cent efficiency 20 per cent bonus is paid, and above 100 per cent efficiency the worker is given at his standard rate *all the time he saves* in addition to 20 per cent bonus for the time he works. The bonus table is as follows:

Efficiency, per cent.	Bonus per $1.00 wages.	Efficiency, per cent.	Bonus per $1.00 wages.	Efficiency, per cent.	Bonus per $1.00 wages.	Efficiency, per cent.	Bonus per $1.00 wages.
67	.0001	78	.0238	88	.0832	99	.1881
68	.0004	79	.0280	89	.0911	100	.20
69	.0011	80	.0327	90	.0991	101	.21
70	.0022	81	.0378	91	.1074	102	.22
71	.0037	82	.0433	92	.1162	103	.23
72	.0055	83	.0492	93	.1256	105	.25
73	.0076	84	.0553	94	.1352	110	.30
74	.0102	85	.0617	95	.1453	120	.40
75	.0131	86	.0684	06	.1557	130	.50
76	.0164	87	.0756	97	.1662	135	.55
77	.0199	87.5	.0794	98	.1770	140	.60

If a man's wages are $0.30 per hour, if in the month he has been present 240 hours and has delivered 210 hours, his efficiency is 87.5 per cent, his wages $72.00, his bonus is 7.94 per cent, its amount $5.72.

The foreman's efficiency consists in the efficiency of the men under him. If all of his men have delivered in a month 7,211.6 hours of standard work but have been paid for 7,523.5 actual hours, then the efficiency of the foreman is 95.8 per cent and his bonus 15.36 per cent on his wages. If work is defective and has to be done over, owing to fault of worker, standard time is credited but once and the efficiency of the man as well as of the foreman diminishes.

It is preferable that standard times should be made public before work is begun, that changes in standard time, whether up or down, should be made on some definitely understood and fair plan, and that the amount of reward for efficiency should also be public knowledge. There are workers so shortsighted as to think that they can prevent a determination of standard times, that they can prevent a determination of individual efficiency and prevent the reward or promotion of efficient men. If the management is fair, skilled, and wise it is not possible to make effective opposition to propositions which can be put into force just as powerfully without publicity as with it, but secrecy harms the worker more than it does the employer. In considering the gains due to efficiency it is not sufficiently taken into account by either employer or employee that net profits are the difference between gross earnings and expenses, that gross earnings could be greatly increased by a growth of the volume of business, and that a shortening of time permits increased output without increase of expenses, therefore reduces the unit expense. If the worker earns $75.00 per month and spends $70.00 his net profits are $5.00 per month; a discouragingly small sum—but if he earns $15.00 in bonus his net profits become $20.00, an increase of 400 per cent. When unit costs (including material) are reduced to the manufacturer even as little as 10 per cent and, owing to standard time and efficiency, a 30 per cent larger output is secured, if net profits were 10 per cent, they become 24.7 per cent, an increase in net of 247 per cent.

The bringing up of an individual worker from 60 per cent to 100 per cent efficiency is to his advantage; the bringing up of a shop from 60 per cent to 100 per cent is to the advantage of its owners; but the bringing up of all shops and all operations in a country from 60 per cent to 100 per cent is to the advantage of all the people. The potential interest of the community in increased efficiency will be considered in the next article.

ERRORS AND DIFFICULTIES IN MANUFACTURING COSTS.

By W. M. S. Miller.

Mr. Miller's study is not directed to any individual cost system, but to the clear understanding of the great elements which go to make up the cost of manufacture, and particularly to the proper treatment of that most perplexing and often deceptive factor—general expense or burden.—THE EDITORS.

THE extremely active competition existing in many branches of the machinery-manufacturing business has created new conditions that are becoming very difficult to meet successfully, being in many cases the result of unsound business methods practiced by short-sighted sales managers in their efforts to take business away from competitors. The publicity and prestige accruing to a smaller concern by reason of its having secured an "important" order against the competition of larger and better established firms, often lead them to go into a negotiation with predetermined intention of sacrificing all profit if necessary in order to secure the business. While larger and more conservative concerns may not attempt to meet such competition, the effect of these low prices remains indefinitely; and at a later time when either concern tries to get similar business at profitable prices, it may be found impossible to do so. Unfortunately it often occurs that the smaller concern, having had little previous experience in building similar machines, or having no accurate knowledge of the costs of machines previously built, find that they had underestimated the cost and actually lost money on the order. This sort of competition is largely responsible for the unreasonably low prices prevailing in many lines, having produced a condition that is equally unfair both to manufacturer and purchaser—unfair to the manufacturer because it prevents his making a reasonable profit, and unfair to the purchaser because it produces a tendency on the part of the manufacturer to cheapen construction beyond the limits of good engineering.

Manufacturers, therefore, of a necessity are paying more attention than formerly to the matter of maintaining cost-keeping systems that will give accurate and intelligible manufacturing costs, and all works where any pretense is made at conducting the business intelligently

now have some sort of a system for obtaining costs on individual orders. In a small shop it may consist in the use of a "time card" or "job ticket" which is made out when the order is entered in the shop and on which all the men who work on that order mark their time. A record of the material used on the order is either kept posted on the job ticket, or the foreman figures up the amount of material used after the job has been completed. Larger factories will have more elaborate systems for keeping costs, the basic features of which are the daily time slip of the workman and a "bill of material" or "material specification" on which the material is charged as it is used. These systems may vary in detail according to the size of the factory, the character of the product manufactured, and the individual ideas of the persons who had to do with the installing of the system.

Without describing in detail any of these shop cost-keeping systems, it may be said that their respective merits vary largely according to the conditions to be met in different works, and the value of the results obtained from any one of them depends more upon the diligence of the foreman in seeing that the workmen charge their time properly, and the accuracy and intelligence of the clerks who compile the costs from these records, than upon the particular system used. There are, however, a number of sources of error which are not chargeable to either of these causes, but are due rather to the methods of treating certain items of expense that are incidental but important factors in manufacturing cost.

The elements that enter into manufacturing costs are of three classes:

Material and Labor,

Indirect Labor and Miscellaneous Factory Expense,

Administration, Sales, Publicity, etc.

The "factory cost" of any machine covers the actual cost of the material and labor required in producing it, plus its share of the indirect labor and miscellaneous indirect expenses in the factory. The amount added to the material and labor cost of an order to cover this indirect or "overhead" expense may be called the "factory burden."

The "commercial cost" of a machine is the factory cost plus its share of the administrative expense. The amount added to cover administrative expense may be called "general burden."

With a shop cost-keeping system that is operated with reasonable accuracy, direct material and labor costs on any individual order should be a more or less positive quantity. The final figures representing factory cost or commercial cost, however, are susceptible to

considerable variation according to the method of determining the burdens, and the manner of treating the various items that enter into them. It is to these things that I wish to call attention.

The highest economy in manufacturing is obtained where it is possible to confine the business to the production of standard machinery. The expense of making new designs, the cost of which is difficult to predetermine, and which consequently cannot always be covered in the price obtained, can thus be kept down to a minimum, and machines built in quantities from standard designs, making possible the use of jigs and other devices for economy in shop operation. Most manufacturers, therefore, endeavor to confine their business so far as possible to the manufacture and sale of standard machinery, yet even under the most favorable conditions it is necessary to make new designs from time to time, and to build a certain amount of what may be considered special machinery. We may, therefore, consider that in every machinery-manufacturing works, there will always be these two distinct classes of machinery going through the shop: standard machinery and special machinery.

On an order for special machinery the cost of the designs, patterns, etc., will form a legitimate part of the cost of the order, and if the order is to be a profitable one will be fully covered in the price obtained. If, however, the order is taken with the intention of eventually developing the design into a standard from which other machines are to be made and sold in the future, then such designs may be considered an asset and their cost charged to capital account, or it may be treated as an expense to be gradually absorbed in the same manner as other overhead expense. The cost of all development, however, including drawing, patterns, etc. for new designs should be taken care of in such a manner that on orders for new machines it can be included as part of the cost of the order, or not, as may be determined after the order has been completed, depending upon whether or not the design will be considered as a future standard. Should the question of the disposition of the charge not come up at all, it should in some manner be taken care of automatically. This may be done by charging the cost of all development and incidental drawings, patterns, etc., to separate "expense" orders; and in reporting the costs on individual sales orders, all expenses incurred covering items of this nature should be appended to the cost of the order.

Separate expense orders should be provided in the works to cover the following: Designing Engineer's Time, Draftsman's Time, Patterns, Tools, Dies, Jigs, etc.

All work for drawing, patterns, or tools should be charged to one of these accounts, whether it be for new designs, for incidental patterns, or for tools for standard machines.

There will be a monthly reserve set aside for "Development" of each class of standard machine, forming a "Development Reserve Account" which will be charged to factory expense. All the above expense orders will be charged to this account, and the monthly balance of the same or the difference between the amount of the reserve and the amount charged during the month will be charged or credited to factory expense. When it is decided to charge all development cost against the profit on the sales order, the development account will receive a corresponding credit. Or if the development is charged to capital account the development account will be similarly credited. Thus all development expense not taken care of in the cost of the order or not charged to capital account will be automatically taken care of in general expense and absorbed in the factory burden.

Returning to the question of costs on individual orders, it will be apparent that by segregating these items of expense and appending them to the cost of the order proper, the normal cost of the order will never be destroyed by the event of unusual development expense, while at the same time the additional item appended to the cost will show what the development expense has come to.

The common practice of determining factory burden on the basis of the ratio of the indirect factory expense to the direct-labor pay roll, while not a theoretically correct one, is in most cases accurate enough for all practical purposes, and in the ordinary shops where the machinery built is all of the same class has proved itself to be very generally satisfactory. It is quite common, however, for a manufacturing concern to build two or more different classes of machinery, or machinery requiring radically different factory equipment, in the same shop, as for instance, electric generators and lighting transformers. The building of generators requires a fully equipped machine shop, with an erecting shop with cranes, etc., while lighting transformers can be built with comparatively little equipment. If, in rendering costs on machinery made under such conditions, the same burden be used for both generator and transformer, the resulting costs would be lower than true costs on the generators, and higher than true costs on the transformers, for the reason that the latter would be made to carry a part of the burden belonging to the generator. To obtain satisfactory costs in such a

plant, rather than attempt to install an elaborate system on the "machine-hour" or "man-hour" basis, it is more practicable and equally satisfactory to segregate the two classes of product in the works so that the factory expense applicable to each can be determined separately and a different burden applied to each. The separation of different classes of product in the shops is very desirable for other reasons also, and should be followed just as far as it is possible to do so.

The plan of applying factory burden as a percentage to be added to direct-labor cost, is based upon the assumption that the amount of indirect labor and other overhead expense applicable to any job is proportional to the amount of direct labor expended upon that job, and as this is never strictly true, the costs made up in this way are fairly accurate only so long as the relation between the material cost and the labor cost is about the same in all of the products made in that shop. Where an order is put through the shop on which the relation between the material and labor is very different from that of the regular product, the cost on such an order will be higher or lower than a true cost according to whether the labor item is proportionately higher or lower than that of the standard product. For instance, if in a shop where the general run of the product has material and labor cost in about equal proportion, an order is entered for a machine on which the material is a very large item, the cost that will be obtained will be lower than the true cost for the reason that the cost of handling and the use of the additional floor space for the excess material will not be covered in the factory burden. For this reason it is very desirable in a large works to separate from one another the products in which the ratio between material and labor is very different, so that the burden for each class of product may be compiled and applied separately to the costs of each.

It may in some shops be quite difficult, and in others it may seem entirely impracticable, to segregate the products to the extent that we have suggested; but in a large works where there is a great difference in the character of the products made, they should be separated even where it may seem very difficult to do so, and it will be found that the ultimate results will fully justify the trouble and expense.

The statements which have been made with reference to "burden" apply only to "factory burden," which has been considered as covering all indirect expense in the works including salaries of works superintendents, foremen, time-keeper, clerks, cost of light, heat, power,

maintenance of buildings, tools, etc., but does not include administration, selling, or advertising expense. The latter items, which are usually termed "general expense," are taken care of in "general burden," and usually applied to the cost of each order as a certain percentage of the total factory costs. In some works the general burden is determined by the ratio of the administration expense to the direct-labor pay roll, or in other words, in the same manner as the factory burden. This, however, is not logical, as there is no reason for assuming that administration expense bears direct relation to the factory pay roll.

In carrying out the plan of having separate burdens for different classes of products it should also be applied so far as possible in the application of the general burden. This, however, might in some cases be quite difficult, but it is essential where the different products handled are subject to very different methods of sale. For instance, some smaller products might be sold through jobbing concerns while the larger machines will be sold by direct representation, in which case the selling expense of each class of machinery should be kept separately, so that each class of product may have its own "general burden."

The spoiling of a certain amount of work is a condition that will always obtain in any factory, even where the most skilled labor is employed and the best material used; regardless of all the precautions that may have been taken to prevent it. When this does occur the cost of the order upon which the work is being done will be excessive, sometimes to the extent of wiping out all of the profit on what might otherwise have been a very profitable order. At other times the amount of the additional cost resulting from the spoiled work may not be enough to cause a loss or even to indicate any abnormal condition, but such a cost if used as a basis for the price in a future negotiation might cause the loss of an order that would have been profitable under normal factory conditions. It is, therefore, very desirable that the additional cost resulting from such spoiled work be either eliminated entirely from the cost of the order on which it occurred, or that in reporting the cost, such extra cost be segregated from the cost proper, so as to show the normal cost of making the machine covered by the order and the extra cost due to the spoiled work.

When the item of cost covering spoiled work has thus been eliminated from the order on which it occurred, it is evident that the manufacturer has been put to an expense for which he gets no returns,

nor would it show against profit and loss account unless some further provision is made for taking care of it. This is best provided for by establishing separate shop expense accounts to which all such items will be charged. At the end of each month the total amount charged to this account will indicate the expense that has resulted from spoiled work during that period, and a review of this account from time to time by the superintendent will be valuable to him in his efforts to keep such expense within minimum limits. As such cost is clearly an expense that is always present to a greater or less degree, it is proper that this account be charged to "factory expense" and absorbed in factory burden. This means that each order will be made to bear its share of this expense, and in reviewing the cost of an individual order on which an abnormal amount of spoiled work has occurred, the item covering such spoiled work can be ignored with the knowledge that such contingencies are fully taken care of in the factory burden.

It is desirable that there be separate shop expense orders for each of the following:

Defective Workmanship,

Defective Material,

Defective Design.

The workman in making out his time slips will be properly instructed by his foreman that all extra abnormal labor will be charged to one of these orders, but no charge will be made to an expense order without authority being obtained from the foreman or his assistant. In entering the charge on the time slip, the expense order number will be followed by the job order number so as to indicate the job on which the spoiled work occurred. The charge on the time slips may read, 30-6743 3 hours. In which case the number 30 may represent "defective material" and 6743 the job number on which the defective material was encountered.

The suggestions given in this paper apply particularly to larger manufacturing plants, as it is in them that conditions obtain that make accurate cost keeping most difficult. The points referred to are, however, important to the smaller manufacturer as well; and by giving them consideration before it comes time to make extensions, the arrangement of the works can be planned with a view both to economy in manufacture and to the facilitating of accurate cost keeping.

The subject of cost keeping is always more or less complicated, and for this reason is one upon which there is a good deal of theoriz-

ing about ideal systems and new ways of doing things, probably because there are so few persons in a manufacturing organization who come in close enough contact with the details of cost keeping to have a practical knowledge of the subject. The cost-keeping system is usually under the jurisdiction of the accounting department, who are apt to make too much of a book-keeping proposition out of it, and to consider that if an accurate account is rendered of the total cost of an order, including all incidental expenses lumped in together, their duty is done; while what the commercial end of the concern requires is the normal cost of each machine built. But they also want the contingencies taken care of in the cost in such a way that each order may bear its share of all these extra expenses. These unusual expenses should also be classified, and monthly reports rendered to those whose business it is to watch them and to keep such cost down to a minimum. When the costs obtained are not entirely satisfactory for their purposes, the commercial head of a concern is too apt to become convinced that the system is all wrong, and if attention is called to some magazine article describing a system that has worked successfully in some other plant, he may immediately want to install it in the works, perhaps without having any definite knowledge as to whether that system is any better than the one already in operation.

I know of a large manufacturing concern which installed two different new systems within a space of two years and at an enormous expense, with a result that for a long time they had costs coming through on three different systems, and it was more than three years before they could get costs that were any way satisfactory. And, unfortunately, after the last system was finally working all right, the costs were not as satisfactory for commercial purposes as the ones they obtained by their original system.

The cost-keeping system of an organization is so vital that it is dangerous to attempt to make any radical changes without due consideration of all the conditions. When it is found that the results obtained are not satisfactory, a careful study should be made of the existing system to ascertain where it is faulty; then such changes should be made from time to time as may seem desirable, thus evolving a system best adapted to the particular line of business, and at the same time avoiding radical changes which might render costs inaccurate during the transition period.

REPRESENTATIVE DATA FROM ELECTRIC POWER-PLANT OPERATION.

AN ANALYSIS OF RECENT FIGURES FROM TYPICAL STEAM STATIONS.

By Howard S. Knowlton.

THE reduction of power costs is a problem of permanent importance to the industrial world. As long as anything like the present margin exists between the potential energy of fuel and the realized energy at the station bus bar, there will be no lack of incentive to analyze the expenses of generation and to seek to find the equipment and combinations of apparatus best adapted to economical power production. Important as is the reduction of generating costs in general industry, it is vitally essential to the broadest commercial success of the modern central station. Figures of cost drawn from central stations where intelligent efforts are constantly being made to reduce the expense of operation are intrinsically suggestive to the power owner and operator in other branches of industry. Not only do they suggest comparisons between similar items common to his own experience; they point out the economy of generating power on a large scale, and in a measure set a limit toward which plants similarly equipped may work.

In the following paragraphs the latest available power costs are presented for seven of the larger central stations of Massachusetts depending entirely upon steam power for the operation of their plants. None of these plants is fortunate enough to be able to generate part of its output by hydro-electric methods. Practically the entire output is produced by coal costing from $3.99 to $4.79 per ton. The equipment of each plant is of modern type, thoroughly representative of good practice in the design of steam generating stations using either reciprocating engines or turbines, and operating condensing. The figures presented are for the year ending June 30, 1908. The companies considered are the Edison Electric Illuminating Company, of Boston, the Worcester Electric Light Company, the Lowell Electric Light Corporation, the Fall River Electric Light Company, the Malden Electric Company, the Cambridge Electric Light Company, and the Lynn Gas and Electric Company.

Table 1 gives the total kilowatt hours manufactured by each company for the year, the capacity of the generating plant in engine horse power, load and fuel particulars.

TABLE 1.

	K. W. H. Manfd.	Coal Used, Tons.	Cost per Ton.	K. W. Max. Load.	H. P. of Engines.
Boston	88,535,490	102,717	$3.99	35,511	73,500
Worcester	5,400,192	7,868	4.79	22,212*	5,900
Lowell	9,426,511	14,101	4.75	3,498	7,390
Fall River.....	4,061,284	7,630	4.68	1,561	4,433
Malden	4,647,453	5,555 coal	4.49	1,575	4,875
		1,000 coke and breeze	3.72		
Cambridge	6,043,204	9,377	4.40	22,772*	6,750
Lynn	8,776,166	13,917 coal	3.60	3,700	8,200
		3,364 bbls. tar	1.50		

The total cost of manufacture is made up of the following items in the figures presented:

Fuel cost, Rentals of Real Estate at Plant, Station Tools, Oil and Waste, Water, Wages at Station, Station Repairs, Steam-Plant Repairs, and Electric-Plant Repairs. In the accounts of the several companies a careful record is kept of these items throughout the year, which are totalized in the returns filed according to law with the Massachusetts Board of Gas and Electric Light Commissioners. The coal used in these stations is in general of a good quality of bituminous, Georges Creek and Pocahontas being favored, while some companies use New River coal. Details of the exact kind of coal burned are not at hand, but it does not differ very greatly in the different cities in price and desirability. In all the plants there is now a good margin between the maximum load and the rated capacity of the machinery. Table 2 shows the toal cost of manufacture, with the component items segregated to enable their proportion to be seen. The importance of the different factors entering the cost of power production can readily be appreciated, together with the factors which deserve the most immediate study in any steam plant in relation to their total yearly influence upon the profits of the enterprise. In each case the fuel cost is the principal element of expense, station wages taking second place.

In the table opposite rentals of real estate were not included, as only three companies had such an expense. For the same reason the cost of station tools and appliances were not included, four companies having such listed expenses. Under the former heading, Boston expended $19,465.87; Worcester, $175.00, and Lowell, $120.00. Under the latter item Lowell expended $1,972.39; Fall River,

* Maximum kw. hour output in any one day.

TABLE 2.

	Fuel Cost.	Oil and Waste.	Water.	Station Wages.	Station.	Plant Repairs. Steam.	Electric.	Total Cost.
Boston	$409,841.07	$7,348.13	$21,667.03	$170,393.66	$13,521.01	$37,269.72	$49,774.01	$729,280.50
Worcester	37,970.06	1,477.31	1,843.79	19,429.59	650.80	2,945.15	2,949.49	67,441.19
Lowell	67,032.97	846.04	730.04	24,742.81	1,881.90	1,859.69	885.54	100,071.37
Fall River	35,707.29	1,302.16	465.12	21,884.77	466.14	1,491.73	1,168.46	65,075.29
Malden	29,479.72	780.55	1,492.24	15,817.19	1,640.23	3,325.22	653.24	54,653.53
Cambridge	41,546.43	1,118.05	3,281.28	20,920.49	1,241.30	3,557.91	2,761.12	74,426.58
Lynn	54,158.32	1,030.83	3,551.79	25,937.79	4,547.00	12,932.54	3,993.03	106,374.03

$2,589.62; Malden, $1,464.14, and Cambridge, $222.73. In the case of Malden, the figure for apparatus and machinery included horse, wagon and automobile maintenance, in addition to tool expenses.

Examining the above tables, it will be seen that the size of the output does not invariably mean a proportionate cost of production, although in a general way the company having the larger output approaches a higher total cost. In all the stations covered by the figures the fuel cost for the whole year represents a sum well worth reducing in every reasonable way. A saving of a fraction of each ton in the coal used amounts to a notable figure in the case of a company like the Boston Edison, whose total fuel bill is rapidly approaching the half-million-dollar mark for twelve months. On a daily basis the coal cost in Boston is about $1,120, and in the plant having the lowest total fuel consumption, Malden, the cost of coal is nearly $81 per day. It is of course possible for a company like the Edison of Boston to purchase coal in enormously greater quantities than the smaller organizations with more limited resources and storage facilities.

The Boston Edison Company's principal station is one of the larger combined engine and turbine plants of the Atlantic seaboard, located on tide water, with admirable coal-handling facilities and condensing arrangements. Economical production is thus possible on a very large scale, and hand labor plays but a small part in the operation of this company's generating equipment. The coal fields of the principal plant at L street, South Boston, have a total storage capacity of about 70,000 tons.

The Worcester company's generating plant is gradually passing through an evolution from belted to direct-connected apparatus, and the adoption of direct-connected engines and a turbine equipment by this company presages still better fuel economy in the future. For the year end-

ing June 30, 1908, the equipment of the Worcester station was in general thoroughly modern, only a moderate portion of the output being handled by belted machinery. During the early part of this fiscal year both the Fall River and the Lowell plants were revised in design, each of these companies now having a turbine station of excellent character. The Cambridge plant is a well-equipped reciprocating-engine station located on the banks of the Charles River, about three miles from its mouth, and the Malden plant is another example of a well-managed reciprocating-engine plant, not located on tide water, but operating a cooling tower in connection with its condensing equipment. The Lynn plant installed two 1,500 kilowatt Curtis turbines about a year ago, in addition to its existing reciprocating-engine capacity, direct-connected apparatus being the order here. The Malden and Lowell plants are each operated by syndicates managing similar properties elsewhere, and presumably have the benefits of data secured under widely different conditions, as well as purchases on a considerable scale.

Oil and waste play but a small part in the cost of operation in all but the Boston station. Here the total quantity used is so considerable that the annual cost runs to over $7,000 per year, not a large sum per kilowatt hour generated, but worthy of constant scrutiny. The cost of water is by no means a negligible quantity in the smaller plants, although it cuts little figure in Lowell and Fall River. In Boston it is about $60 per day, while at the extreme end of the line, in Fall River, it is less than $1.30 per day. Local conditions, of course, affect the terms under which water can be secured, but these figures show that the water question is by no means unimportant, after all, and deserves more constant study in some cities than it has received. It would seem that in some instances a reduction in the water rates might properly follow such improvements in the municipal service as the voluntary adoption by lighting companies of more efficient lamps, like the tungsten or tantalum units, giving the public service of superior quality at less cost, as in street lighting. A station which is obliged to pay for every gallon of water used in its boilers at a high price is entitled to some reduction, in my opinion, if it installs for the city tungsten lamps of greater candle power for the same net rate per year, even taking into consideration the gain in efficiency.

The totals of station wages show the importance of studying further the capacity of employees to handle boilers, engines, turbines and auxiliary machinery, as well as the labor requirements in the

electrical side of the plant. Few data of complete character exist on this point. So far as the returns of these companies to the Gas and Electric Light Commission show, the following are the approximate number of employees required in power-station operation:

	Employees.
BOSTON.	
Generating steam division	136
Generating electrical division	98
Total	234
WORCESTER.	
Firemen	5
Engineers	4
Other station attendants	16
Total	25
LOWELL.	
Engineers	5
Oilers and cleaners	4
Station electricians	6
Boiler plant	10
Total	25
FALL RIVER.	
Employees not classified in returns.	
MALDEN.	
Engineers	4
Oilers	3
Steam fitters	2
Firemen	3
Switchboard men	2
Total	14
CAMBRIDGE.	
Engineers	4
Oilers	3
Firemen	6
Engine wipers	1
Coal passers	2
Switchboard men	4
Total	20
LYNN.	
Engineers	6
Firemen	6
Oilers and cleaners	4
Coal passers	2
Switchboard men	22
Total	40

Station repairs are clearly an item affording little chance for comparison, depending upon many other considerations than the work of the machinery in any given period. It is of interest to note that in most cases electric-plant repairs were less than steam-equipment re-

pairs. The reliability of electrical machinery is pretty well established by this time, and the problem of maintenance, in the best modern apparatus, has been brought within very reasonable figures.

Table 3 represents the approximate cost of power on the unit basis, the cost of the different items indicated in Table 2 being calculated per kilowatt hour manufactured. Some of the smaller quantities in this table are only approximate, on account of their low proportion to the total cost of production at the station. Under "miscellaneous" are included rentals, tools and tool maintenance.

TABLE 3. COST IN CENTS PER KILOWATT HOUR MANUFACTURED.

	Boston.	Worcester.	Lowell.	Fall River.	Malden.	Cambridge.	Lynn.
Fuel	.462	.703	.710	.880	.635	.690	.618
Oil and waste....	.008	.027	.009	.032	.017	.019	.012
Water	.024	.034	.008	.012	.032	.055	.040
Wages	.192	.360	.262	.538	.342	.347	.296
Station repairs ..	.015	.012	.020	.012	.035	021	.052
Steam repairs ...	.042	.055	.020	.037	.072	.059	.147
Electrical repairs.	.056	.055	.009	.029	.014	.046	.045
Miscellaneous ...	.023	.000	.022	.080	.033	.000	.000
Total.....	.822	1.246	1.060	1.620	1.180	1.237	1.210

In examining the above table it is obviously not feasible to separate the power generated in the stations of any of the companies before they were remodelled during the year, from the power generated by the later apparatus. This condition is so widely present in power-plant analyses, however, that it need not be regarded as vitiating the general lesson of the table, which is the wide difference in the unit cost of the various factors entering the expense of power generation in the same general locality. These considerations encourage the further study of itemized costs on the unit basis in all plants where the desire to reduce expenses to the lowest point consistent with reliable service is a controlling factor. Time and money expended by individual companies in the interpretation of their cost records are worth a great deal in the long run. If the reasons for discrepancies are known, the possibility of applying a remedy can be intelligently considered. Local conditions will often modify the costs more than appears at first indications.

EDITORIAL COMMENT

The Aeroplane in War.

BRITISH watchfulness, ever alert against anything destructive to the protection afforded by England's fleet-encircled insularity, has risen in warning against the flying-machine.

Prof. Newcomb's apparently well-grounded demonstration of the very small efficacy of the aeroplane as a war engine (published in the *Nineteenth Century* for September and reviewed at length in our November issue) has brought to minds of this type not reassurance, but increased agitation, and Major B. Baden-Powell replies to Prof. Newcomb in the November *Nineteenth Century*.

The introductory argument of the advantages and asserted disadvantages of the aeroplane offered in rebuttal of Prof. Newcomb's case may be passed with little comment. It is fair to assume that when Major Powell speaks of the aeroplane as traveling "infinitely faster for the same propulsive power," he intends to use the language of enthusiasm rather than that of engineering; his assertion that the aeroplane is "practically invulnerable to bullets" must perhaps be left to future demonstration, though we would be disposed to back the machine gun very heavily as the winner on that issue; but when he offsets the objection that the aeroplane "can not stop to have its machinery repaired or adjusted" by the plea that "the engines could be stopped for a few seconds while the machine soars downwards," he is taking the discussion out of the bounds of practical engineering. The prospect of effecting mechanical repairs to the power or transmission of an aeroplane during "a few seconds" of downward soaring is not attractive from a mechanical point of view.

It is on the military side, however, that Major Powell's enthusiasm for the aeroplane leads him to the most curious proposition of all. Turning to the question of the invasion of England he asks "what valid reason is there why, within a few years' time, a foreign nation should not be able to dispatch a fleet of a thousand aerial machines, each carrying two or three armed men, and able to come across to our shores and land not necessarily on the coast, but at any desired inland place?"

Let us suppose that there is no valid reason why the 2,000 or 3,000 armed men should not be landed at any place, coast or inland, and let us ask Major Powell in return what would they do—3,000 men in the middle of England with only such ammunition as they could carry, without field guns, without cavalry, without commissariat, wagon trains, or base of supplies—with nothing but their rifles and a few cartridges?

Wage Systems.

MR. BENDER'S commentary on the Gantt bonus system in our December issue, while undoubtedly a fair statement of his own observations, to the best of our judgment does not express an average impression of the results secured, probably because it was not based upon typical examples. Nothing is more certain than that the personal equation leads to varying results in the installation, administration, and interpretation of any system, and the best interests of engineering progress demand the greatest freedom in the expression of individual experience and opinion. Mr. Bender's comparisons are valuable in proportion to his opportunities for observation and his accuracy in deduction, and it was not the disposition of this Magazine, in pub-

lishing them, either to curb his liberty of opinion or to assume coincidence with it.

To avert any chance of mistake, however, it is fair to record our dissent from the view that the appearance of "psychological disadvantages" is characteristic of the use of the bonus system. A salient feature of this system, indeed, is its advantageous grasp of psychological principles, especially that principle laid down by Mr. McFarland in the leading article of that same (December) issue—that "to show the men that it is to their interest to produce the highest efficiency, the most practical way . . . . . is to provide an adequate reward." Nor does it stop here. A more subtle psychological perception yet dictates the further step that discipline is better enforced by reduction from the bonus class to plain day wages than by dismissal. The discharged man is a martyr; the reduced man is a butt for ridicule.

Concerning the preliminary removal of causes of inefficiency, the painstaking provision of the best instructions that can be prepared by the best experts in the accomplishment of the work, and the offer of liberal reward for success, there can be little difference of opinion. The point at which the workman's co-operation as an originator of methods should be enlisted, the fixation of the standard, or of any definite minimum, to be attained, and the incidence of the bonus (whether gradual or sudden) are perhaps fairly debatable questions. There is strength, however, in Mr. Gantt's argument that the workman should not become instructor until he has learned all that skilled specialists can teach him, and that the margin of possible extra accomplishment should not be left so very wide that employers are tempted to reduce it by raising the task or cutting the bonus, when from their point of view excessive earnings are made. Certainly the Gantt system is known to have produced excellent results in many places where it has been applied.

For a Tariff Commission.

THE call for a National Tariff Commission Convention to be held in Indianapolis February 16 to 18, 1909, has been issued by a group of more than twenty important manufacturing and commercial organizations, led by such bodies as the National Association of Manufacturers, the Merchants' Association of New York, the Manufacturers' Association of New York, and the Boston Chamber of Commerce. The purpose is "to give immediate and adequate expression to the existing public demand for the creation of a permanent, non-partisan, semi-judicial tariff commission, which shall collect, collate and study industrial and commercial facts in this and other countries pertaining to the tariff question, for the information and use of Congress and the Executive."

We have long held the conviction that whatever tariff we have, its adjustment should be in the hands of a non-partisan body—expert, judicial, above reproach or approach, at least equal to the Interstate Commerce Commission in dignity and authority—and that the adjustment should be continuous, not spasmodic. Our present method of infrequent revision means periodic dislocation of the whole manufacturing and commercial body.

We let everything get wrong because the machinery for righting tariff inequalities is so cumbersome to start, and when it is to be put into operation everything else in the country stops. Under a competent commission the process of continuous readjustment would be as little disturbing to business at large as the operation of the courts. The time is peculiarly suitable for a revision that will revise justly, and the inauguration of a new mode of regulating our tariffs that will avert for the future the alternating periods of vicious stagnation and distressing upheaval we have experienced in the past.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

THE BAGDAD RAILWAY.

A DISCUSSION OF FINANCIAL ARRANGEMENTS, PROGRESS OF CONSTRUCTION AND PROBABLE ECONOMIC RESULTS.

Edwin Pears—The Contemporary Review.

AMONG the many striking features of the beginning of the new era in Turkey, none is of more importance than the signs of a desire for the development of the internal resources of the Empire. The recent appointment of Sir William Willcocks as adviser for irrigation work in Mesopotamia and other parts of the Empire is indicative of the intelligent and increasing activity in this direction. The men who have made the revolution recognize fully that improved transportation facilities are necessary for the proper development of the wealth of the country and the Minister of Public Works has declared that roads and railways will have his first attention. Of the latter the major project for a number of years to come is likely to be the completion of the already planned and partly executed Bagdad Railway. A long article on this project is contributed by Mr. Edwin Pears to *The Contemporary Review* for November, 1908. Mr. Pears is principally concerned with the political aspects of the railway but we abstract from his paper a few paragraphs of general interest on the methods of financing the work, the progress already made and the probable economic results.

"The proposed line starts from a village named Haidar Pasha, on the Asiatic side of the Bosphorus, and immediately opposite Constantinople. It goes to Ismidt, the ancient Nicomedia, and thence to Konia, the Iconium of St. Paul's travels. Thence it crosses the range of the Taurus Mountains to the east of the famous Cicilian Gates to Adana, whence, crossing the Amanus range, famous for the struggles between Alexander the Great and the Persians, it strikes eastward running along the southern slope of the Taurus, crosses the Euphrates near Birejik, about ninety miles from the Bay of Alexandretta, and still going east to Helif, where there will be a junction for Mardin on the north, it continues its course through Northern Mesopotamia, turning in a southeasterly direction till it reaches Mosul on the Tigris, near the site of ancient Nineveh. From thence the line will follow the Tigris on its right bank until it reaches Bagdad. There it will diverge for a few miles to the south-west, and recross the Euphrates not far north of Babylon, passing through Kerbela, the ever-sacred city of the Schiah Moslems. Then it will follow the latter river on its right bank to Bassora or to some other place on or near the Persian Gulf.

"The time has gone by to say that the railway cannot, and will not, be made. It has been commenced, and has been opened for traffic over a distance of nearly 600 miles, 125 miles beyond Konia. An agreement was concluded on June 2 last for advancing it further to Helif near Mardin. It is now reasonably certain that the railway will be completed to the Persian Gulf in a few years."

The history of the project is as follows: "In January, 1889, while Sir William White was the British Ambassador in Constantinople, an English group with a small Austrian interest, which was in possession of the railway from Haidar Pasha to Ismidt, was forcibly dispossessed by the Porte, and their railway given over to a German group. The English group had a right of preference in the case of extension beyond Ismidt, and their expulsion was a flagrant violation of their rights. The dispossessed group received the sum of 133,000 pounds as compensation from the Porte. The German concessionaires formed an Ottoman company known as the Anatolian Railway Company, and were subsequently allowed to extend the railway from Ismidt to Konia.

"During the following ten or eleven years the project for extension of the railway from Konia to Bagdad had been seriously considered by the Germans and the Turkish Government. Two other groups had been endeavoring to persuade the Porte to grant them the concession to build the Bagdad Railway, one of which was represented by a strong international syndicate. They were at a disadvantage because the Germans were already in possession of the head of the line at Haidar Pasha. In July, 1903, the negotiations with the Germans, which had been greatly stimulated by a visit of the Kaiser to the Sultan in the autumn of 1902, resulted in the granting of an Imperial Firman, which allowed the Anatolian Railway Company to extend the existing line to Bagdad. The Firman stipulated that the concessionaires should form a new Ottoman company to work the new concession. Shortly afterwards this company was formed, and took the name of the Bagdad Railway Company.

"Many of the features of the concession are remarkable, and so far as I know unique. The Turkish Government finds money to enable the company to build the railway, and guarantees an annual revenue of 15,500 francs per kilometre when it begins to work. The railway is to be built in sections of 200 kilometres (125 miles each). The first of such sections, beginning at Konia, where the Anatolian line ended, and extending to Eregli, has already been completed and opened for traffic.

"The Turkish Government provides for the building of the line in the following way: When the financial details regarding the construction of each section of 200 kilometres have been arranged between the Government and the Bagdad Railway Company, a convention embodying them is signed. Against its signature the Government hands over to the Company a number of negotiable Government bonds. These bonds represent the capital necessary to secure at 4 per cent., with a small addition for redemption, an annual interest of 11,000 francs per kilometre and for 200 kilometres. In consideration of this delivery the Company undertakes to build the railway. In the case of the first section the Government paid 54,000,000 francs, which works out as payment of a nominal sum of 170,000 francs, or £10,800 per kilometre. This is the paper value, but the amount actually realised will, of course, be somewhat less.

"The Turkish Government will, of course, have to pay interest on these bonds from the date of their emission. But in order to urge on the completion of the work it stipulated that the interest paid during the time of the construction and until the line is declared ready for traffic, shall be returned by the Company to the Government.

"The amount thus paid to the Company for building the railway is admitted on all hands to be ample. Indeed the Company's report shows that in the first section there was a large profit; but that section was through a level country, one of easy construction. The following sections will be much more costly on account of the engineering difficulties which will have to be encountered. Still, no one doubts that the Company has a reasonable chance of making a good profit on the construction.

"The section of the line having been built, the question of the profit or loss on the working has next to be dealt with. The Turkish Government provides a guarantee for the working of the rail-

way in the following manner: The Company is allowed to keep the annual receipts of the railway up to the amount of 4,500 francs per kilometre. If the receipts do not amount to this sum, the Government undertakes to pay the difference. The receipts in excess of 4,500 francs up to 10,000 francs per kilometre are to be credited to the Government; above 10,000 francs they are to be divided, sixty per cent. to the Government and forty to the Company.

"The Government guarantees the Company an annual income of 4,500 francs per kilometre for working expenses. How the guarantee works out may be illustrated by an example. Suppose the receipts in any one year are 3,000 francs per kilometre, then the Company will retain the 3,000 francs and the deficit, namely, 1,500 francs, will be paid by the Government. Apart from this, the Government will have to pay 11,000 francs for the service of the construction loan, or a total of 12,500 francs.

"As with the first section built, so also with the second, as to which the terms and conditions were agreed to in June last. This convention covered four sections of a total length of 840 kilometres or 525 miles, the most difficult and costly part of the line. It extends from Eregli, 125 miles beyond Konia, to Helif, a town 25 miles south of Mardin. The crossing of the Taurus range presents serious engineering difficulties, and the Germans propose to make a new survey of the district and have been given until next June within which to present their plans.

"By thus dealing with the line in separate sections the Porte hopes that the whole line to Bagdad and beyond to the Persian Gulf will be completed. The owners of the concession are to have the usual advantages of taking ballast from the Government quarries, of cutting timber in the Government forests, of making harbors, quays and warehouses at Bagdad, Bassora, and other places and of utilising water power for electric traction. The concession gives a number of preferential rights to mines in the vicinity of the railway, and so many rights to construct branch lines as almost to constitute a monopoly of railway traffic through a wide tract of the Empire from the Capital to Bagdad. The most valuable concessions are those for the building of branch lines to places of considerable population and where it is believed a good paying traffic can be at once found.

"It is beyond all doubt that, in the interests of the population of Asia Minor, the railway should be built. It will develop the resources of the country and materially lessen the poverty of the inhabitants of the districts through which it passes. Hitherto the difficulty of getting goods to market has prevented the cultivation of land. I have repeatedly chronicled the fact that to carry corn down to a seaport costs more than a like article, coming from Russia by water, or even from the United States, could be bought for at such seaport. The result has been that lands have been allowed to go out of cultivation. The peasants have grown only sufficient for their own wants. Men who in any European country would be living in comparative affluence are in poverty. This is the case even in Mesopotamia, which under other conditions would be as fertile as Egypt. It is, of course, true that misgovernment, non-government, and the want of security for life and property have produced this poverty, but the want of means of communication, of taking their stuff to market, and the insecurity of such miserable roads as exist are the results of such misgovernment. A well-managed railway would go far to assure to the peasant the fruit of his labours.

"Commerce and trade have been frightfully hampered in Asia Minor by the cruel restrictions upon the simplest form of travel, which in the case of Armenians meant a total prohibition to go from one place to another. These restrictions have been only recently abolished by the Committee of Union and Progress. The railway will not only increase facilities for travel and transport but gradually, insidiously even, lead to the removal of other hindrances to commerce. Everywhere the prospect of the railway being opened is welcomed as a great reform. Wherever in Turkey railways have been worked there has

followed a notable, even a quite remarkable, increase in production. Fifteen years ago not a single ton of grain reached the sea-coast for export from the districts from which the Anatolian Railway runs. During the last four years the annual grain export alone from the same districts averaged 1,250,000 Turkish pounds, say £1,150,000 sterling. In the same manner the two lines from Smyrna have enormously increased the exports from that city.

"The establishment of the Bagdad Railway will confer two great advantages upon the Turkish Government itself and many smaller ones: first, it will cause an increase of revenue from the increased produce, which for the first time can be sent to market at a profit; and second, a further very large portion of the public revenue will be placed under the Department of the Public Debt, which means that it is really being placed under international control."

THE RELATION OF RAILWAYS TO CANALS.

THE NEED OF WATER TRANSPORTATION FACILITIES IN THE UNITED STATES AND THE PRINCIPLES ON WHICH CANAL BUILDING SHOULD BE UNDERTAKEN.

John F. Stevens—Atlantic Deeper Waterways Association.

A CONSIDERABLE part of the discussion of the problems connected with the improvement of inland navigation in the United States, which are now receiving so large an amount of public attention, centres around the relation of railway to water transportation, the economic possibilities of canals in the face of railway competition and the probable attitude on the part of the railways to any large scheme for the improvement of inland navigation. These questions were discussed at length by Mr. John F. Stevens at the convention of the Atlantic Deeper Waterways Association in November last. We take the following extracts from his paper from *Engineering News* for December 10, 1908.

"Within sixty years—about one hardy business lifetime—our railway main lines have risen from nothing to 225,000 miles, over which traffic, both freight and passenger, is carried, at speeds equal to, and at rates, generally speaking, lower than in other countries, where the cost of labor and material is much less than with us, and where the density of tonnage is far greater. But a time has now come when the railways, considered as a unit, are not capable of handling satisfactorily the interchange business of the country, even supplemented as they are to a certain extent by water lines.

"The gigantic strides our internal commerce has made, have demonstrated that while railways serve a purpose which waterways can never do, they need to be supplemented by a cheaper, if a slower carrier. There are immense volumes of low-grade traffic, which to be moved at all require very low rates. Such traffic is now being handled by the railways to the detriment of their other and faster-moving business, at a loss to themselves and to the public also.

"There seems to be a general impression that the railways are opposed to the exploitation and construction of canals. That there is good ground for such opinion, the writer does not believe. The consensus of opinion among our ablest, most far-sighted railway owners and executives is undoubtedly that canals, properly planned, honestly financed and constructed, will not only aid the development of the country, but will create new business, and be of assistance and value to the railways themselves.

"It is improbable that private capital can be found to finance—excepting, possibly, in a few unimportant instances—such systems of canals as the public needs may find necessary; and if the demand—which is already insistent—that the national government take up the matter, is granted, then it clearly devolves upon the national authorities to see that such systems are so planned, and the work is so executed, that the greatest good to the greatest number will result. And such work will naturally divide it-

self into three classes: the improvement of harbor facilities, the enlargement and control of rivers, and the creation of new and the rebuilding upon more generous lines of existing canals.

"The improvement of harbors, and the fitting of such of them as may be most available, in connection with interior transportation lines, to become suitable terminals for foreign business, is in itself a great and important work: and the mistake of spending millions for deep water, for ample room with safe anchorage, and neglecting to provide means for cheap and quick exchange between ships and interior lines, must be avoided. By the lack of such foresight, New York has built up Baltimore, Norfolk and Newport News, and the business which now avoids her port, because it can be done cheaper elsewhere, will never come to her doors. In fact, the providing of ample and well-arranged terminals is the greatest single item among the many which go to make up the total of efficient transportation facilities.

"The matter of building a railroad at the present day is a different proposition than it was in years past. Now, as a first preliminary, the amount, nature and probable revenue of all prospective traffic seeking movement, is carefully estimated. These factors, with such reasonable additions as future development may seem to warrant, fix the character of the road to be built, from right of way to equipment, and hence, the amount of the investment in the proposed enterprise. And the same sound principles should be observed in the planning of canals. They should be fitted for the work they will be called upon to do, as far as it can be predicated.

"First, and foremost, should come the big trunk lines, to be built where no doubt can exist that the business waits, or will develop, for them, and where nature has provided, without prohibitory cost, physical conditions which make them feasible.

"After such trunk line or lines are decided upon, then the question of branch or feeder lines should be given the same careful consideration, and the relations of such minor links in the general scheme, to the whole, including the railways should be thoroughly worked out; and the dimensions which govern the capacity and consequent cost of operation of every one, trunk and branch lines alike, should only be decided after the most intelligent and painstaking inquiry, remembering always, that the cost and delay of transferring freight from one vehicle to another is generally more than the hauling of it for many miles. The construction of a canal, or of a system of canals, is a simple matter, as compared to the conception of, and the correct solution of all the preliminaries.

"Once financial means are assured, once we establish the policy that such adjuncts to our present lines of traffic are to be provided, a wild and senseless scramble will ensue for 'a slice from the pork barrel.' Every little town, every city—not to mention every state—will demand to have its own little pet canal, and such demands once conceded, would not only cover the face of nature with useless and unsightly scars, but would drive the nation, and probably some of our states, nearly to bankruptcy. The only way to prevent such wasteful results will be to take the whole matter absolutely out of politics—as much so as the deliberations of the supreme court.

"We might have a commission large enough in numbers so that the details of work could be divided and yet not large enough to become unwieldy, the members to be selected, not by reason of party proclivities, or geographical distribution, but because of their known ability as business and transportation men, in the broadest meaning of the terms. Such men should be paid salaries commensurate with those they can earn in private life, and the tenure of their office should be fixed, not by the caprice of political necessity, but by a natural age limit of retirement, with a fair pension thereafter until the end of life. If we are going to spend, as has been suggested, from fifty to one hundred million dollars each year for an indefinite period, we can spend none of it more wisely, than in providing the very best counsel and supervision that the talent of the United States affords.

"Such a commission should be given the final power of decision, not only as to details, but also as to the general, and, in fact, all features; with the authority to examine, accept or reject, as it saw fit, any project advanced for consideration; to plan and to carry into execution, by contract, or otherwise, any work it might decide upon as proper to be done, subject, of course, only to regulated financial limitations.

"And such a course would, it is believed, meet with the approval of leading men of the railway world, in common with all other thinking citizens. It would be as much—probably more—to the benefit of the railroads to have the locating, planning and construction of waterways carried along on sound business principles, as it could possibly be to any other commercial interests.

"Looking into the future, there is another factor, which, although a side issue, may become a very important one. In the construction of canals, as a natural result, there will be the development of a large amount of water-power, which, properly handled, can be made to produce, at a low cost, power, heat and light, through the medium of electricity. This will enable us to conserve our coal supply, and thus to add millions to our material resources which we are drawing so heavily upon. And no interests are more concerned in the cheapness of power—whether produced from coal or any other agency—than the railroads. For this reason alone, they should feel a deep concern in the successful inauguration of a canal system from which they are bound to derive such substantial benefits."

THE CHARACTERISTICS OF A FOREMAN.

A DISCUSSION OF THE PROPER TRAINING SCHOOL FOR THE DEVELOPMENT OF THE BEST TYPE OF FOREMAN.

Engineering.

IN the issue for December 18, 1908, *Engineering* comments editorially on the gradual change which is taking place in the characteristics of foremen in the mechanical trades. Before manual labor had been so extensively superseded by machinery, the primary qualification of a successful foreman was superiority in handicraft, the moral and mental qualities of self-control, administrative ability, etc., being of secondary importance. The application of mechanical methods of manufacture however, has affected the order in relative importance of the necessary qualifications, and the successful foreman of today must be a man of thought, of independence of character and of administrative ability. *Engineering* discusses as follows the best school of training for the development of these qualities:

"There are many who doubt the expediency now of promotion from the bench to the foreman's post. It is contended that the changes in methods of manufacture are so radical that there is not now the same need for the superior handicraftsman—that what is required is a controller, a master of method and of organisation. We can only accept this contention with the important proviso that the man of thought who is to be the ideal foreman of the future shall first have such a practical training at the bench as to have acquired a sound knowledge of workmanship and a complete sympathy with workmen. Contact is imperative for both acquisitions; without them a man cannot control men or methods. There is nothing more subversive of discipline than the ridicule even of one man, and it is quickly awakened, and justifiably so, by the slightest display of incapacity to do any bit of work. A man cannot be a really efficient foreman without being a capable workman. He must, however, be more than that, and the elements of development are in this direction; so also are the divergencies from unanimity of opinion.

"The workman who aims at being a foreman must secure as great a degree of technical and general education as is possible to him. If the attendance at

evening classes involves hardship and self-sacrifice, the result is advantageous in the formation of character. It is important that he should know, for instance, about the qualities of the metals used, the principles of mechanics and physics, and the whys and wherefores of the details of the designs to be embodied in metallic form, as well as the elements of machine-tool design and power distribution. There are other important studies, but these examples suffice. Even in the case of a ship-fitter, smith or forgeman, where manual labor obtains still to a large extent, there is need for technical training. And in all cases there is possible great gain by the pursuit of knowledge which, although not immediately useful, tends to general culture. This point need not be elaborated here; the development of a disciplined mind will be regarded as of great importance.

"Drawing-office experience is equally necessary; but the cases are very rare where a foreman who has been trained exclusively as a draughtsman has been successful; there is always the lack of intimate knowledge of workmanship. Indeed, it is possible that a prolonged period in the drawing-office may partly unfit for foremanship a man with earlier workshop training. The atmosphere of the drawing-office, and the psychological conditions prevailing, are very different from those obtaining in the shops. In the one case the problems are associated with strains requiring calculation, and there is more or less of mechanical method; in the other the difficulties are connected with personal idiosyncracies, where conditions do not repeat themselves and cannot be standardised. In the one instance it is mathematics, in the other humanity. A foreman should be able to easily read a drawing and to readily discern an inaccuracy. This latter raises a point which has involved heartburnings between the drawing-office and the shops. The duty of the workman, the machineman, is to obey: to follow his drawing implicitly. Any other rule would mean confusion. But this scarcely holds with the foreman, who from his practical experience in the shops and drawing-office ought to be able to suggest modifications which are acceptable, because they simplify machining or fitting, or for other reason. The foreman who neglects to make, and the draughtsman who refuses to accept, such suggestions fail in their duty.

"There are some firms who only promote men to foremanship if they have been in the premium, bonus, or costs department. This course is satisfactory; but again we must interject the reservation as to the duration of service in a department which is only an adjunct to the factory. The premium-bonus system has proved very satisfactory; but there is a tendency to make too much of it. The happy mean is difficult to strike, and in this, as in many other cases, our English pastime of hobby-riding is very pronounced. The card system is another case. We have heard of a works where there is a staff appointment of a 'card-inventor.' Inventors, to which class belong premium fixers and card and index-makers, are like mothers whose goslings are all swans. Where they have uncontrolled sway there is trouble. What is wanted is a reasonably good system of premium standards and cards, which should be altered reluctantly, and only on unquestionable grounds. They should be operated conscientiously. A foreman ought to know the system well to be able to restrain and regulate the rate-fixer. Men who become imbued with the spirit of the card system sometimes have their imagination limited by the four edges of the card. That is well for one who is to remain a member of the premium-bonus staff, but it is otherwise with a foreman.

"The training of the successful foreman should thus be composite. He should have a liberal education, although this, fortunately, may be supplied in later years by reading and other means of culture. He should have a sound training at his trade in the shops; this is indispensable. Technical training is invaluable, and to this should also be added some experience in the drawing-office and costs department. But to these there must be added those qualities which mark men as leaders. There is, first, ambition in the truest sense, and the

readiness to suffer privation in achieving an end. This is akin to self-discipline, to the development of a well-balanced mind, and, therefore, to a strong sense of the relative importance of justice and right. These two will enable him to avoid nepotism and favouritism—two of the greatest pitfalls. This, it may be urged, is a gospel of perfection; but it is well, once in a while, to aim high. Moreover, we are persuaded that employers could do much by encouraging intercourse betwen foremen to a greater degree. There are, it is true, foremen's associations but they are not sufficiently supported by the men who could profit by them; nor do they meet often enough. It is important that there should be considered at their meetings economic and social problems associated with production as well as purely technical questions, while visits to works at home and abroad should be arranged at frequent intervals. Nothing tends more to efficiency in management than perfection of system, and many hints in this direction could be gleaned by travel. There should be no difficulty: one firm might welcome the foremen of another in exchange visits, to the advantage of both. Even an international exchange might be possible. But in any case there can be nothing but advantage from any effort to improve the characteristics of foremen. On them the economy of production greatly depends. They should be exemplary, being first men, as well as oversmen, even at six o'clock in the morning."

THE REPAIR OF MARINE BOILERS BY AUTOGENOUS WELDING.

A DISCUSSION OF THE ADVANTAGES AND DIFFICULTIES OF THE PROCESS AND THE SECURITY OF ITS RESULTS.

André Le Chatelier—Revue de Métallurgie.

A VERY interesting and comprehensive paper on the employment of autogenous welding for the repair of marine boilers, by M. André Le Chatelier, appears in the *Revue de Métallurgie* for November, 1908. We have not space to review his valuable practical notes on the methods of executing repairs of various classes but we quote at length from his discussion of the safety of repairs made by the autogenous welding process.

For the repair of all classes of boilers the process offers two advantages of capital importance: first, it permits water-tight and durable repairs to be made without the use of rivets, which, although the only method of repair available up to very recent times, has always proved unsatisfactory on account of the tendency of riveted repairs to develop leaks after a greater or less period of service; and, second, it offers a means of effecting repairs impossible by any other process, and in many cases of avoiding the necessity of replacing furnaces or other important parts of boilers or even of whole boilers. Extensive corrosion of the tube plate, due to leakage of the tubes, or of certain parts of the furnace walls where a riveted patch could not be counted on to remain water-tight would in most cases lead to the condemnation of the entire boiler. The repair of such damage can be rapidly and cheaply effected by the autogenous welding process and the cost of replacement of the whole boiler avoided.

In the particular case of marine boilers the process, generally the most economical method of repair under any circumstances, is of especial importance on account of the rapidity with which repairs can be executed. Repairs of any magnitude by riveting are not only expensive in themselves but they keep the vessel out of commission for days or, in many cases, for weeks. On this account boilers are usually kept in service as long as possible without repair with the result that deterioration goes on at a very rapid rate. Autogenous welding offers a means of effecting repairs of considerable importance during a stay of one or two days at a port, and a judicious and frequent utilization of the process results in keeping the boilers always in good condition. The process

has a very important application in the case of boilers too badly damaged to be repaired by any other means. In many cases the costly replacement of certain important parts or of the whole boiler may be avoided or at least postponed for several years. This is especially of importance in the case of old vessels whose boilers are worn out but whose hulls are capable of several years' service, but not enough to warrant the installation of a complete new boiler plant.

The question of safety is of so much importance that in many quarters it is considered unwise to employ autogenous welding for the repair of boilers, especially for executing repairs of much importance. Distrust of the method has been caused by the fact that not infrequently welds made by inexperienced workmen break throughout their entire length. In considering the extent to which this distrust is well founded it is important to recall the modifications which take place in the mechanical properties of metals at temperatures around 200 degrees C. to which the boiler plates are subjected. These are, briefly, first, an increase in the ultimate strength in tension, second, a decrease of about 12 per cent. in ductility, and third, a decrease in malleability in about the same proportion. These modifications are produced by a transformation of which the nature is little understood and of which the effects are most clearly manifest between 100 to 200 degrees C., the range of temperatures to which boiler plates are commonly subjected. The most troublesome effect is the great reduction in ductility and malleability. The furnaces and fireboxes of boilers particularly are subjected to stresses due to expansion and contraction, which, notwithstanding special designs of plates used in their construction, eventually destroy the elasticity of the metal and give rise to the flaws and cracks which appear in the furnaces of all marine boilers at the end of a few years' service.

As regards repair by autogenous welding, however, these modifications in mechanical properties offer no difficulties. They are the same for the metal of the weld as for that of the plate. It is only necessary that the welding material should be a steel equivalent in quality to the material of the plate and of as low carbon content as possible, the latter because the reduction in malleability depends to a great extent on the amount of carbon present in the metal. A well-made weld will show resistance and extensibility values amounting to 80 per cent or more of those of the plate, a higher value than is possible with riveted repairs.

But the most important point to be considered in connection with autogenous welding is that of brittleness. At the point of welding the metal has been melted and cast and has lost a large part of its power of resistance to shock. It is possible to restore this quality to a certain extent by reheating the weld and by hammering at a red heat, but in general a weld can not be counted on to be so free from brittleness as the rolled plate. As a matter of fact the quality of fragility would not necessarily render a steel unfit for use in boiler construction were it not accompanied by its correlative fissility. The later quality is of capital importance. In a fissile steel a crack once started is extended very rapidly by very small stresses. It is evident that a steel of this nature could not be incorporated in a boiler without the risk of serious accident. When a weld is badly made and does not extend through the whole thickness of the plate, the unwelded part forms the nucleus of a crack equally dangerous with those formed at the surface of the plate through the influence of expansion and contraction. Distrust of the autogenous welding process on this account merits serious consideration and seems at first sight justified by the frequent breakages of welds throughout their entire length under comparatively slight shocks. If welds made by this process retained when hot the fissility they might possess when cold it would indeed be unwise to employ autogenous welding to any great extent in the repair of boilers. But, fortunately, the temperatures between 100 and 200 degrees C. which have so serious an influence on the malleability of the steel have a most bene-

ficial effect on the fragility and fissility. The latter are qualities characteristic of low temperatures and they diminish very rapidly as the temperature rises, a rise of even 5 degrees producing an appreciable improvement in the steel. Above 100 degrees they no longer exist, and between 100 and 200 degrees two steels which, when cold, would have shown very different degrees of fragility and fissility will be practically identical so far as these qualities are concerned. The result is that a crack which in cold metal would be extended by very slight shocks is increased only by considerable deformations at a temperature above 100 degrees. Hence a weld which might when cold be of a quality much inferior to that of the plate will become of practically the same quality when hot, so far as fissility is concerned, and will possess no special danger. If badly made, of course, the flaw will increase in extent, but gradually and without the danger of sudden and complete rupture. If the weld is made with a good quality of metal, if it is uniform throughout the entire thickness of the plate, and if as an additional precaution it has been reheated, it will give perfect security. In fact experience shows that when welds in boiler plates fail it is almost always immediately after they are made, rupture being caused by the stresses due to contraction to which they are subjected at that moment.

M. Le Chatelier described at length the various applications of autogenous welding which may be made in the repair of various parts of marine boilers and gives numerous illustrations of work executed at Marseilles. He emphasizes the fact that the process is not simple. On the contrary it is a very delicate operation requiring for its success a great many precautions and a high degree of skill on the part of the workman. The lack of skilled workmen is the most serious obstacle in the way of the extension of the use of the process. The workman using it for the repair of boilers must not only be manually dexterous but he must have a keen sense of responsibility. The manual dexterity can be obtained in from 6 to 9 months but the moral qualities are so rarely found that there are not above ten workmen in the whole world, outside of Italy, to whom the more important repairs could be entrusted with perfect safety, and not above 20 others capable of performing satisfactorily the more ordinary operations. The process is, however, making rapid strides. At the end of 1907 it was used for repairing marine boilers only at the ports of Marseilles and Genoa, but during the past year it has been introduced in Belgium, Holland, Spain, Germany, England, Russia, Roumania and Brazil, and there is no doubt that within a few years facilities for executing repairs by autogenous welding will exist in every port of importance in the world.

THE NATURE OF ALLOYS.

AN ELEMENTARY GRAPHICAL DESCRIPTION OF MODERN THEORIES AS TO THEIR FORMATION AND CONSTITUTION.

Engineering.

AS an introduction to a review of three highly technical papers based on modern theories as to the constitution of alloys, read at the first meeting of the newly formed Institute of Metals, *Engineering* for November 20, 1908, gives one of the most lucid descriptions of the elements of these theories which has come to our notice. For specialists in metallurgy and metallography, of course, so elementary a discussion will possess but little interest, but we believe a majority of engineers will find in the following full abstract a valuable presentation of a subject concerning which little is generally known. It is of especially timely interest for our readers in connection with Mr. Becker's discussion of high-speed steel which begins on another page of this issue.

"According to the modern theory an alloy in general resembles a mass of

granite which consists of a number of entirely different constituents in the crystalline state, held together by the solidified mother-liquor, from which the crystals in question were deposited during the process of cooling. The crystals which separate out before the mass solidifies as a whole, may, in theory at least, either be chemical elements or definite chemical compounds, or more generally 'solid solutions.' What is meant here can best be illustrated by taking an example.

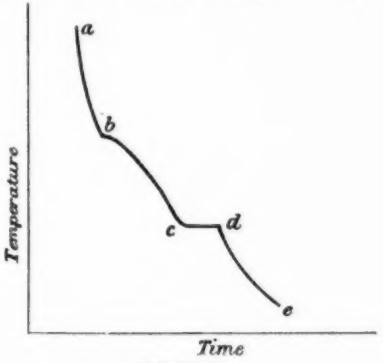


FIGURE 1.

"If an alloy of two metals is melted and allowed to cool, and an autographic diagram of the temperature taken during the whole time of cooling, a curve is obtained which is generally of the character represented in Figure 1. From *a* to *b* the temperature falls steadily with the time, but at *b* the rate of cooling slackens, and it appears that at this point crystals of one of the two constituents crystallise out, so that the portion remaining liquid is poorer in this constituent.

"As the temperature falls further, more of the constituent in question solidifies, thus still more impoverishing the mother-liquor, and the part of the curve represented by *b c* is traced. At the point *c* the mother-liquor itself begins to solidify, and until this is completed the temperature remains constant, tracing the horizontal part of the curve *c d*. Following this the temperature falls uniformly again, as indicated by *d e*. The crystals deposited during the period corresponding to *b c* are relatively large, whilst those deposited during the freezing of the mother liquor are very small.

"If the two constituents of the alloy are denoted by Y and Z respectively, then in the ideal case the crystals first deposited consist solely either of the metal Y or of the metal Z; whilst during the period corresponding to *c d*—that is, during the freezing of the mother liquor—the solid separated consists of minute crystals of Y laid down side by side with similar minute crystals of Z. This solid is known as the eutectic. Whatever the proportion of Y to Z originally present in the alloy, this eutectic contains exactly the same proportions of the two metals. It is, however, in no sense a chemical compound, but consists, as stated, of separate crystals of each metal laid down side by side.

If the same metals Y and Z are melted in a different proportion than in the case represented in Figure 1, the point *b* in the new diagram will make its appearance at a different temperature than before; but the temperature corresponding to the freezing of the eutectic, represented by *c d* in the figure, will be constant for all cases. Hence, by plotting the temperatures corresponding to the point *b* for all proportions of the two metals, a diagram similar to the upper line in Figure 2 is obtained.

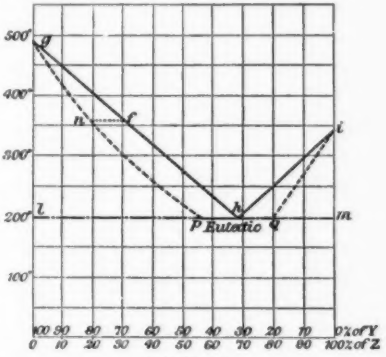


FIGURE 2.

"The diagram shows that the pure metal Y melts at temperatures of 490 degrees, and the pure metal Z at 340 degrees. An alloy containing 70 per cent. of Y and 30 per cent. of Z is perfectly fluid until the temperature falls to 360 degrees. At this point, represented by *f* in the diagram, it begins (still keeping

to the ideal case) to deposit crystals of the pure metal Y. Hence the mother liquor is impoverished in Y, and will not deposit more of this metal unless the temperature falls further. As it continues to cool, however, more and more of the metal Y is deposited, until at last the temperature reaches 200 degrees, at which temperature the mother liquor consists of 32 per cent. of Y and 68 per cent. of Z. At this point, corresponding to the line *c d* in Figure 1, both Y and Z freeze out simultaneously and the whole mass solidifies. Up to this time one portion on the total mass has been liquid, and another portion solid. Similarly a melt containing 80 per cent. of Z and 20 per cent. of Y begins to deposit crystals of Z at a temperature of 250 degrees, and freezes into a solid mass as before at 200 degrees. Drawing a horizontal line *l m* across the diagram at 200 degrees, we have the two critical temperatures shown for all proportions of the constituent metals. One of these critical temperatures, that corresponding to the point *b* in Figure 1, varies with the proportion of the two metals originally present; but the other, the temperature corresponding to the freezing out of the eutectic, is constant.

"The state of affairs described above is an ideal one, not satisfied accurately by an alloy. In general, when the Y component begins to freeze out at the point corresponding to *b*, it carries down with it some small proportion of the metal Z. Hence the crystals first formed are not pure Y, but a solid solution of Z in Y. Similarly, if Z is the metal to freeze out first, it carries with it a certain amount of Y, the crystals then formed being a solid solution of Y in Z. These solid solutions are also known as 'mixed crystals,' a not altogether fortunate term, which would seem almost more applicable to the eutectic. It is really meant to imply that the crystals first separated contain less Z than those coming down subsequently, there being a continuous increase in the proportion of Z held in solid solution until the eutectic proportions are reached. In other words, for the case in which Y crystallises out, the proportion of Z dissolved in the crystal varies with the temperature at which the solidification is effected. On the other hand, the proportion of the two constituents in the crystal deposited at any temperature is not the same as in the mother liquid at the same temperature.

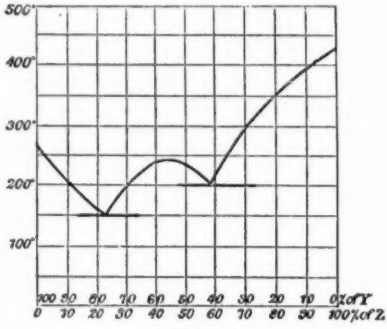


FIGURE 3.

"Thus whilst the line *g h i* shows the composition of the mother liquor at any temperature, that of the crystal which is separated at the same temperature is widely different. Thus in Figure 2 another line, *g p q i*, can be drawn showing the composition of the crystals which separate out at any temperature. Thus the composition of the crystals deposited from a mother-liquor containing 70 per cent. of Y and 30 per cent. of Z can be found by drawing from *f* a horizontal line cutting the line *g p* at *n*, which, it will be seen, corresponds to a composition of 82 per cent., Y carrying, in solid solution, 18 per cent. of Z. It will also appear from the diagram that the eutectic consists of two sets of crystals, one (corresponding to the point *p*) containing 54 per cent. of Z dissolved in 46 per cent. of Y, and the other (corresponding to the point *q*) 20 per cent. of Y dissolved in 80 per cent. of Z. When the mutual solubility of the two metals in each other is small, the point *p* lies close to the 100 per cent. line for Y, and the point *q* close to the 100 per cent. line for Z. Alloys having compositions corresponding to points on the left of *p*, or the right of *q*, do not deposit eutectics.

"The case represented in Figure 2 corresponds to one in which the two constituents do not unite to form chemical compounds. When such a compound is

formed the complete curve can be drawn by combining two diagrams, one obtained when the mixture consists solely of the metal Y and the compound Z Y, and the other when the mixture consists solely of the metal Z and the compound Y Z. These may then be juxtaposed to form the complete curve.

"The kind of curve then obtained is represented in Figure 3. Taking, again, the ideal case in which no solid solutions are formed, but pure constituents separate, the diagram shows that for compositions containing more than 78 per cent. of Y, the latter crystallises out alone until the temperature falls to 150 degrees, when the eutectic solidifies. This eutectic does not, however, consist of crystals of Y, laid down simultaneously and side by side with crystals of Z, but of crystals of Y laid down side by side with crystals of the compound Y Z. For mixtures containing less than 78 per cent. of Y, and more than 56 per cent., the crystals which first separate out are crystals of the compound Y Z, and the eutectic is the same as in the previous case. When next the mixture contains less than 56 per cent., but more than 42 per cent., of Y, the diagram shows that the crystals which first separate out are crystals of YZ; and the eutectic now formed consists of crystals of the compound YZ and of the metal Z, the metal Y being absent in the uncombined state. The melting point of this eutectic is 200 degrees. Finally, when the mixture contains less than 42 per cent. of Y, the metal Z crystallises out first, and the eutectic finally formed is again that melting at 200 degrees. In actual practice the crystals formed are never quite pure, but each is a solid solution. If the two constituents can form more than one compound, the curve will be still more complicated. A hump like that shown in Figure 3 generally denotes the presence of a compound, the composition of which is represented by that of the maximum ordinate."

THE VALUE OF THE IMPACT TEST.

AN OUTLINE OF TYPICAL METHODS OF IMPACT TESTING ON NOTCHED BARS AND AN ESTIMATE OF THEIR VALUE.

F. W. Harbord—Institution of Mechanical Engineers.

SO many methods of testing steel by impact have been suggested by engineers during the last few years that it has become a matter of importance to investigate the value of these tests as compared with the ordinary tensile tests, upon which in the past it has been the custom largely to rely, and also to compare the better-known methods of impact testing with each other, to see which gives the most concordant results. An investigation of this sort was recently undertaken by Mr. F. W. Harbord with the objects, first, of comparing the results obtained by different methods of impact testing, and, second, of determining whether such tests detected any irregularity in steel not revealed by the ordinary tensile tests, and to what extent they are in agreement with each other, the results of which were communicated to the Institution of Mechanical Engineers on November 20, 1908. Mr. Harbord's paper contains a vast number of data which it is impossible for us to reproduce; the following brief abstract is limited to his outline of typical methods of impact testing and a very general summary of the conclusions he has drawn from the results of his tests.

The materials used in the tests comprised three very high class Sheffield steels, referred to as "standard steels," and a series of steels made by the acid Bessemer, acid open-hearth, basic Bessemer and basic open-hearth processes, so that all steels used by engineers for structural and railway work were represented. In all, over 800 bars representing over 40 different steels were experimented with. In the experiments with the standard steels, six duplicate tests were made on each steel by each of the methods investigated, except in a very few cases when material was available for only two or four tests. Tensile tests

of all the steels and hardness tests by the Brinell method were also included.

"Broadly the methods of impact testing may be divided into four or five classes, each having its supporters, and all being more or less used by different engineers and metallurgists. The methods of testing in common use may be divided as follows:

1. One notch in the centre of the bar: two supports: fracture effected by a series of blows of a falling weight. *(Seaton and Jude.)*

2. One notch in the centre of the bar: two supports: fracture effected by one blow of a falling weight. *(Frémont.)*

3. One notch not necessarily in the centre: one support: fracture effected by one blow on overhung portion from a falling pendulum or weight. *(Izod.)*

4. Two opposite notches not necessarily in the centre: one support: fracture effected by a series of blows of a falling weight on overhung portion. *(Brinell.)*

5. Same as 4, but with an arrangement for reversing the bar after every blow." *(Kirkaldy.)*

The five methods indicated in italics above were chosen as representatives of the five general classes of impact-testing methods mentioned. The tests were carried out on each machine under the direction of the inventors, Mr. Harbord supplying the test bars already machined to the size taken by the different machines. The test bars were all cut from rolled bars of approximately the same section and into which about the same amount of work had been put in rolling. They were also subjected to the same heat treatment to remove any possible stress due to cold rolling.

"In the Frémont method the test-piece is machined to the size 35 by 10 by 8 millimetres. It has a groove 1 millimetre deep in the centre and is supported on a bearing at each end with the groove downward, and is broken by one blow from a falling weight striking it in the centre. The residual energy in the weight not expended in fracturing the specimen is measured by allowing the weight and broken test-piece to fall on a steel plate placed directly below the test bar and supported on two strong springs. The compression of these springs so produced is measured and recorded by a lever, the short arm of which is attached to the steel plate, while the long arm is provided with a pointer or pencil which travels over a graduated scale. The energy required to fracture the bar is the difference between the original impact energy of the weight, deduced from its mass and height of drop, and the residual energy as recorded on the scale. The error in reading amounts to about 0.3 kilogramme with a 10-kilogramme weight, or about 1-75 of the energy required for a fairly tough sample.

"By the Izod method a sample 2 inches long, ⅜ inch wide and 3-16 inch thick, with a V notch, supported at one end in a clip or vise, and held vertically, is fractured by one blow from a swinging pendulum striking the overhung portion, the residual energy in the pendulum being measured by the arc through which it swings after fracturing the sample. This residual energy is recorded by a special attachment. In this method, as in the Frémont method, an exact measure of the energy expended in fracturing the sample within a very slight error is obtained.

"In the Seaton and Jude method the sample, 4 inches long and ½ inch square in section, with a V notch in the centre ⅛ inch wide and deep, is supported on a bearing at each end, and broken by a series of blows from a falling weight striking it on the centre. The weight and height of drop can be varied at pleasure, according to the class of steel under test. The energy absorbed in breaking the samples is calculated into foot-pounds. In the case of ductile steels requiring a number of blows, say seventy or more, the actual energy absorbed can be obtained to within one blow—that is, 1-70 or so of the total energy; but in the case of brittle steels requiring only one to three blows, the error is still one blow, equal at the least to one-third of the total; or even if one-half the last blow be taken as the breaking weight, the error would still be one-sixth of the total.

"In the Brinell method the sample of the same form and dimensions used in the Seaton and Jude method, with two

opposite V notches each ⅛ inch wide and deep, is supported at one end in a suitable block and fractured by a series of blows on the overhung portion. The tests may be made in two ways—namely, with the notch either horizontal or vertical. In this method, as in that of Seaton and Jude, the force required to fracture the bar is calculated into foot-pounds, and the degree of accuracy largely depends upon the number of blows which the steel stands before fracture. In ductile steels the error would be small, but in hard steels comparatively large. A very serious objection, however, to this method of testing in the case of ductile steels is that when the notches are horizontal after a few blows, but before the fracture, the bar bends so much that the notch in the under side entirely closes, and the test cannot be continued."

Mr. Harbord attempted to prevent this by slotting away a portion of the bar on one side of the notch down to the depth of the latter. In the case of the ductile steels, however, it was found that even this expedient would not produce accurate results and the tests by the Brinell method were abandoned.

"In the case of the Kirkaldy method the sample is of the same dimensions as that used by Seaton and Jude and Brinell, but instead of V notches it has two opposite circular grooves, each ⅛ inch wide and deep. The test bar is supported in a suitable block or vise at one end, and fractured by a series of blows from a falling weight on the overhung portion; but after every blow the entire block is turned over by a cam attachment, so that blows are delivered alternately on each side of the test bar. In this method, as in the Seaton and Jude, the force required to fracture the bar is calculated into foot-pounds, and the degree of accuracy largely depends upon the number of blows which are required to produce fracture; owing, however, to the reversal after each blow, the number of blows required to produce fracture, even in very brittle steels, is comparatively large, and consequently the error is not very considerable, and in moderately ductile steels is inappreciable."

The results of the first series of tests on the three standard steels, which contained respectively 0.26, 0.32 and 0.41 per cent. of carbon, to determine whether the method of testing could be depended upon to give concordant results in duplicate tests on the same material, showed such wide variations that it was considered advisable to extend them to steels of inferior quality but of uniform composition and structure before drawing any general conclusions. A certain number of bars were therefore heated to 1230 to 1250 decrees C. to destroy their ductility partially and half of them were partially restored by re-heating to a lower temperature. Tensile tests of the bars thus treated showed them to be uniform and free from marked irregularity, but the results of the impact tests showed still wider variations from concordance than those on the untreated bars.

"The variation in duplicate tests by the same method is so important that it is desirable to consider these somewhat in detail. In the case of the 0.26 per cent. low carbon untreated steel we find that the Kirkaldy vertical gives the most uniform results, showing a variation of only 2 per cent., while the Kirkaldy horizontal gives the maximum variation on duplicate tests of 30 per cent., the maximum variation shown by the other methods being 25 per cent., and the minimum 7 per cent.; and these if they stood alone might be considered satisfactory as approximating to the variation in duplicate alternating and tensile tests. If, however, we consider the overheated steels, we find the Seaton and Jude method showing a mean percentage variation of 69 per cent., Izod 35 per cent., and Kirkaldy methods 29 per cent. and 27 per cent. Turning, however, to the restored steels, we find the same methods giving totally different results, and instead of the Frémont methods showing the best results with a variation of from 20 per cent. to 25 per cent., we get a variation of 57 per cent., while the Seaton and Jude shows 60 per cent., the Izod method showing relatively small variation for this low carbon steel.

"An examination of the 0.32 per cent. and 0.41 per cent. carbon steels by Seaton and Jude methods gives a variation

of 55 per cent. and 50 per cent. respectively for the overheated, and 48 per cent. and 95 per cent. for the restored; by the Frémont method, 14 to 16 per cent. for the overheated, and 78 to 109 per cent. for the restored; by the Kirkaldy horizontal, 59 and 60 per cent. for overheated, and 29 per cent, for the restored; and the Kirkaldy vertical, 36 and 49 per cent. If we examine each steel, it will be seen that some methods show the greatest variation on the overheated bar, others on the restored bars, so that there is nothing in the results to suggest that variations are due to lack of uniformity in the steels.

"From a consideration of the above it seems reasonable to assume that the irregularity disclosed by the different methods of impact testing is not due to lack of uniformity in the material, but largely, at all events, results from the defects of the method of testing, and it is a serious question how far methods showing such variations should be relied upon by engineers to differentiate between the physical properties of different materials."

Without going into details it may be said that wide discrepancies exist also in the results of the tests made on the standard and commercial steels to compare the impact method with the tensile and alternating-stress tests. "Taking the results as a whole, the Kirkaldy methods and the Izod method give results more in accordance with the tensile tests, and also show less variations in the duplicate tests, but some of the results obtained by these methods vary so much that their value seems very doubtful.

"The claim of the supporters of impact testing is that it indicates certain latent defects not shown under a static test, and therefore it is unfair to condemn impact results when they do not agree with the tensile tests; to some extent this is true, and if experiments had shown that duplicate tests might be relied upon to agree with each other within reasonable limits, and the results were in general agreement with experience, this contention would carry much weight; when, however, we find tensile tests on two steels show a difference of only about 4 tons with approximately the same elongation, and these results are confirmed by the analysis, and then impact tests of two such steels show by two methods the relative brittleness to be as 100 is to 16 and 100 to 21, while other methods give totally different results, one has very seriously to consider the value of these tests."

THE MANUFACTURE OF HIGH-SPEED TOOLS.

NOTES ON THE MANIPULATION OF HIGH-SPEED STEEL IN THE MANUFACTURE OF TOOLS.

O. M. Becker—Cassier's Magazine.

MR. O. M. BECKER, who begins on another page of this issue a series of articles on the nature and characteristics of high-speed steel, has contributed to *Cassier's Magazine* for December, 1908, a practical discussion of the manufacture of tools from high-speed stock. Most of the disappointment which has been experienced with the results of the introduction of high-speed steel has been caused, he says, by improper methods of treatment. The making of the common forms of tools is so simple, however, that it can be undertaken in almost any shop having tool dressing facilities, provided the smith is willing to forget a few of the things he has learned about carbon steels and is prepared to learn a number of new things concerning the new materials. A few of the more important points are noted in the following extracts from Mr. Becker's paper.

The use of annealed stock is usually preferable. If unannealed stock is used the tool has to be annealed to insure an even temper and the absence of strains. If annealed bars are used this annealing process may be avoided. Annealed stock is more easily separated into the proper lengths for tools, it is more convenient for forging, and it can be readily machined.

"For forging any good fire, a common

forge fire among the rest, will serve, though, indeed, here, as in other cases, the better results can be expected where the better appliances are used. The first essentials are to secure the required heat and to keep air currents away from the tool when heating. This is accomplished in part by keeping a deep and clean fire. Coke is better than the ordinary smith's soft coal.

"Very good results are often obtained with small tools thus heated in an open fire. More satisfactory results may be expected, however, if a fire-brick hood is built over the fire. This serves to prevent the radiation of heat and the circulation of air currents, and is a necessity in heating tools of any size in a common forge fire. It also makes it easier to conform to another prime essential, bringing the heat up gradually and evenly on all sides of the tool so as to penetrate uniformly throughout. This point is very important. Unless the mass to be forged is uniformly heated throughout it will work unevenly, with the result that internal strains are set up which may easily cause a failure of the tool when it is put to work, if not before. Furthermore if the heating be too rapid there is a liability that the same thing will happen; that is that internal cracks will be formed which will later ruin the tool.

"It does not follow, on the other hand, that the heating must be tediously slow. If heated too slowly the heat soaks up into the neck or shank, and when hardening takes place this important part of the tool loses part of its natural toughness, a thing to be avoided, as already pointed out. The fire should therefore be clean and well supported by good fuel. Care must be taken withal that the fire be not too keen, or it will not heat through properly. In that case the outside is likely to be white hot and the tool apparently well prepared for hammering, whereas in fact the interior may not be at all ready for working, only the outside being in proper condition. If the interior is not at least hot enough to be bright red, it is not ready for hammering. It is, of course, impossible to know the condition of the interior of a piece of heated steel except by its behavior under the hammer after removal from the fire, and it is therefore largely a matter of personal judgment based upon experience to determine the proper time during which a particular tool is to be heated. As a general guide it is safe to assume that a piece having a section not larger than one inch, if properly protected as advised above, or if heated in a good coke, oil or gas furnace, will be ready for forging when the exterior has reached a bright yellow. No hammering should be done under any circumstances when the steel is under a bright red, for fine cracks are almost sure to develop if nothing worse occurs. Quite often tools that have been forged at too low a temperature burst while being hammered or machined, and still more often while being hardened. Sometimes the damage does not appear until the tool suddenly fails in service.

"It is better to do all forging at an orange or canary yellow even than at a bright red, though different makes of high-speed steel vary more or less in this respect. The makers usually give explicit directions on this point. The temperature range, therefore, is a hundred or more degrees above 1000 degrees C. With this kind of fire, however, exact temperatures are a matter of no concern, since it is impracticable to measure them under these conditions with any degree of accuracy. Anyway, all that is necessary in the way of temperature regulation, no matter what kind of fire is used for forging, is to keep the heat above a bright red, and the eye is as good a guide as is necessary for that.

"Although it is possible, as has just been said, to obtain excellent results with a common forge fire when protected by a hood, and even without the hood if sufficient care be taken, it really does not pay to depend on such crude appliances for turning out tools which shall be uniformly satisfactory in their performances. Especially in a shop where considerable tool smithing is done, a suitably designed furnace is indispensable. A gas forge naturally is the most convenient. The temperature is very easily regulated, and the heating of the tool can

be watched from beginning to end. The cost of fuel is greater than with other types of forges, though this is offset by the greater convenience and certainty of results. Oil forges are sometimes used but are not to be recommended. Where gas is not available or where it is thought to be too costly a fuel, a coke or anthracite furnace can be used to advantage, serving as well for the hardening heats as for the forging.

"The proper heat having been obtained, the forging is done in the customary manner, care being always taken that the temperature does not fall below a bright red, as has been already mentioned. It is well to shape the tool as closely to the required design as possible without over-refinement, in order to reduce the amount of grinding, and for this reason gauges for testing the form of the tool should be freely used during the progress of the work. In some cases, in forging the steel to the required shape, it is even desirable to use forms in connection with the anvil. There may be a combination gauge giving all the angles required in the tool, or, less conveniently, there may be a gauge for each. Mr. Taylor describes and illustrates a gauge consisting of a small surface plate with a hole in one corner, into which is fitted a cone, giving the angle made by the heel of the tool with the face of the plate. He also describes and illustrates a limit gauge, indicating the limits within which the nose of the tool must be forged. These limits may vary in different shops according to the opportunity for grinding. Where the facilities for automatic or semi-automatic grinding are excellent the forging may be less accurate. Hand grinding, however, is more expensive than forging, and where this is necessary the forging should be quite close to the required dimensions. A simple sheet-metal gauge is found very convenient and it is necessary to have a set of these, giving all the angles for the several tools to be made, each gauge giving all the angles for the tool for which it is intended.

"For testing the form and angles of the Taylor standard tools the limit gauge already mentioned would be used, or perhaps something more simple, such as a piece of sheet metal of suitable thickness to hold its shape permanently and having the exact shape of the top of the tool. At the end opposite the nose is the angle supplementing the angle at the heel of the tool, against which it is placed when testing, the base of the tool and of the gauge both resting on the surface plate.

"No tool should be forged, however, which can without prohibitory expense be machined from stock. This generalization practically limits forging to tools made entirely of high-speed steel for lathes, planers, shapers, and slotting machines. Even these tools, however, can in certain cases be made with the stock and supporting portions of machinery steel, while the cutters are of high-speed steel. In such cases the forging for these is eliminated, as in the case of milling cutters and other formed tools."

THE AUTOMOBILE ENGINE OF THE FUTURE.

A DISCUSSION OF THE PROBABLE PERSISTENCE OF THE PRESENT TYPE AND THE IMPORTANCE OF THE STUDY OF FUELS AND COMBUSTION PHENOMENA.

Thomas L. White—The Iron Age.

THE question of the ultimate internal-combustion motor for automobiles and its probable fuel is dealt with by Mr. Thomas L. White in an interesting review in *The Iron Age* for January 7. Mr. White believes that we are drawing to the close of a period of empirical construction and entering upon a period of systematic research, but he does not look for any radical changes in motor design. Further gains in thermal efficiency, he says, can only result from a more thorough study of the physical and chemical changes which occur in the working fluid from the moment that it enters the carburettor to the moment when it leaves the exhaust. We quote at length from his argument.

Mr. White first comments on the significance of the neglect of alcohol as an automobile fuel in Europe, although the alcohol motor has a thermal efficiency of over 30 per cent. and alcohol is cheaper on the Continent than gasoline. "The fact of the matter is that the present type of automobile motor is the outcome of a number of determining conditions of which the necessity of using gasoline was only one, and the current impression that it is the low pre-ignition temperature of gasoline and air mixtures that has prevented the use of high compressions is only partially correct. There are other reasons which are just as cogent. One of them is that the high pressure motor is not suited for lay use. In inexperienced hands the compression is apt to be lost, owing to the piston rings and valves giving out through want of attention. Another is that the high pressure motor is a violation of the accepted canon of automobile design that power must be sought in the direction of speed and not in the direction of weight. Still another objection, and, perhaps, the most important of all, is that it is difficult to the verge of impossibility to control the ignition of a high speed motor under conditions of varying load, unless the quality of the mixture can be depended on to be absolutely the same at all speeds. Where the fuel is vaporized by the ingoing air this condition is rarely attainable. The same trouble is experienced with the high compression suction producer engine. Here it is the percentage of free hydrogen in the producer gas which varies with the speed of the motor, and the opinion is held by many engineers that the presence of this hydrogen, in spite of its great fuel value, is a positive disadvantage.

"Engineering progress is not as a rule along the lines which are technically the most desirable, but along the lines which have been set by economic necessity, and as a reason, though not a technical one, for the conservation of the present type of motor must be reckoned the natural inertia of the existing order. This is inimical to revolutionary policies. From a business standpoint the introduction of a new fuel for use with the current equipment is a vastly better proposition than the introduction of a new type of motor to burn a new kind of fuel, no matter how good the latter may be. Also it must be remembered that gasoline will for many years be an alternative fuel. In fact, in some localities it will continue to be the only fuel obtainable, and as the automobile in its capacity as a long distance vehicle has no fixed base of supplies, it will be necessary for it to be able to get along on gasoline on occasion, at any rate until the coming fuel is so widely used that a supply of it can always be depended on.

"If, as seems to be the case, the long supremacy of gasoline, and other causes of a less ephemeral character, have left a permanent stamp on the design of the automobile motor, then it is to the chemist that we must look not only for aid in the fuel question, but also for information about the phenomena of combustion, to enable us to use the type of heat engine which we have to the best advantage. The time has come when physical and chemical research must supplement a too narrow devotion to the purely mechanical side of motor engineering. To quote Prof. Vivian B. Lewes in this connection, 'The engineer relies upon his indicator diagrams and tests of horsepower for information which could be much more easily obtained by analysis of the exhaust gases, and if this method of investigation were employed important advances would very soon follow. Analyses of the exhaust gases from motor engines are remarkably scarce. Indeed, I do not know of any in this country. But Mr. Sorel, in 1903, published in France some results in which he showed that with a motor running at 1061 revolutions per minute and using 382 grammes of gasoline per brake horse power hour, the products contained unburned compounds which represented 82 per cent. of the hydrogen and 42 per cent. of the carbon present in the original fuel, thus reducing the heat value of the gasoline used in the cylinder from 11,278 to 5085 calories.'"

"The analysis of the exhaust gases from the explosion motor, important though it may be, is, however, only a step,

It reveals the last stage of the complicated reactions which have occurred during the expansion stroke, but it affords little information as to the actual nature of these reactions or of the heat changes which accompany them. If carbon be slowly oxydized in the open air, as in the decay of wood, or almost instantly consumed behind the piston of an engine, the amount of heat liberated and the final product are the same. The difference is not in the process, but in the conditions under which it is conducted, and the final goal of the work of the chemical engineer is the determination of the how, why and when of those factors, which in the case of the decaying wood and of the burning fuel are so widely divergent.

"Some of the results which are coming to light in connection with the study of the energy transformations which occur in the motor are sufficiently startling. Thus it appears that carbon monoxide is absolutely inflammable in the absence of water, and, further, the velocity with which an explosion in a mixture of this gas with air is transmitted depends on the amount of aqueous vapor present. Again, there are reasons for believing that the propagation of the flame in the cylinder of a gas engine is not by direct inflammation, but by the adiabatic compression to pre-ignition point of successive layers of the mixture. It also seems that the old belief that carbon will burn to carbon dioxide in the presence of an excess of oxygen is not altogether well founded. Under certain conditions the lower oxide is just as likely to be formed as the higher.

"The fact is that the idea that during the expansion stroke of an explosion motor the carbon and hydrogen of the fuel simply burn up more or less quickly must be abandoned. What really happens is infinitely more complex. Thus every reaction which can occur in the cylinder is reversible within the temperature, pressure and concentration limits of the cycle. Moreover, it is probable that the combustion of the mixture is far from being of a uniform character throughout its mass at any given moment. There is reason for believing that different reactions may occur simultaneously at different points of the working fluid. It is possible, for instance, that water is being formed and decomposed at the same moment during the same explosion.

"As there seems to be little doubt that the fuel which will take the place of gasoline will be a blend with an alcohol base, it is becoming important to be able to trace the effect of each individual ingredient in a mixed fuel. It may be pointed out that the properties of a blend are far from being a mere statical average of the properties of its constituents, for each admixture has a functional as well as a quantitative effect on the behavior of the whole in the motor. Thus the addition of acetylene to alcohol by accelerating its combustion in the motor increases its efficiency. Lastly, it may be mentioned that the increase of the calorific value of a fuel by blending has no effect on the specific power of the motor in which it is burned. The maximum power of a given motor is independent of the calorific value of the fuel which is used in it, the popular belief to the contrary notwithstanding."

AN AUTOMATIC SYSTEM FOR FIRING OIL FUEL.

A DESCRIPTION OF A SYSTEM INVOLVING AUTOMATIC REGULATION OF FUEL, AIR AND STEAM SUPPLY.

C. R. Weymouth—American Society of Mechanical Engineers.

SOME details were given in these columns in the last number of THE ENGINEERING MAGAZINE of the results of extensive fuel-economy tests on the new oil-burning Redondo plant of the Pacific Light and Power Company, near Los Angeles, California. It was noted that for firing the six boilers of the 5,000 kilowatt unit on which the greater part of the tests were made an automatic system of regulation was employed, which controls the supply of oil to the burners,

the supply of steam for atomizing purposes, and the supply of air for combustion. We abstract the following description of this system from an exhaustive paper on the subject read by Mr. C. R. Weymouth at the recent annual meeting of the American Society of Mechanical Engineers.

An automatic system of regulation is a marked departure from ordinary practice. Practically all stationary oil-fired boiler plants are subject to hand control throughout. "It is customary to maintain a uniform oil pressure at the oil pump and in the oil pressure main, and to throttle the supply of oil by hand at all of the individual burners. It is also customary to operate with full boiler steam pressure on the mains supplying steam to all the burners, and to regulate by hand the supply of steam for atomizing purposes, at each of the individual burners. Boiler dampers are also subject to hand control on the individual boilers."

With hand regulation, however, high plant efficiency is rarely attained. In a plant having twenty 500 horse-power boilers with 60 burners, working under a fluctuating railway or lighting load, there would probably be not more than two, or at most three, firemen to the shift. The rear boiler dampers would probably be clamped in fixed positions, wide open or nearly so. The supply of steam to the burners would receive little attention, but the supply of oil would be regulated for variations of load by throttling to the extent necessary for maintaining the desired steam pressure. There would be a more or less uneven rate of firing at the various boilers, and an excess of air for combustion at all loads, particularly at the lighter ones, corresponding to a nearly uniform rate of flow through the furnace. The attempt is frequently made to operate on a reduced air supply, with the result, if the dampers are set for mean or nominal load, that the chimneys will smoke excessively on overloads before the limited number of firemen can reach all the dampers to close them.

"As the lamentable result of these conditions, the average boiler plant efficiency with crude oil, even with the best types of boilers, averages much nearer 70 than 80 per cent, which is possible in large plants under proper methods of control. Probably it will always be impossible to instill into the mind of an ordinary fireman such knowledge of the principles of combustion and the losses due to excess air supply, as to obtain economical results in large stations where it is necessary to depend on hand firing. Improved conditions can be secured by the employment of a boiler room engineer whose duty it is to scrutinize all fires from time to time and to coach the firemen in their duties; but the only ideal method seems to be an automatic system of control, such as will be here described, where the various adjustments, having once been made for economical conditions, are automatically repeated for the various conditions of load, maintaining a high average economy from month to month. With well-designed oil furnaces and careful adjustment under uniform load conditions, carefully conducted tests have shown that it is possible to obtain high percentages of CO_2, indicating as low as 10 per cent excess air over the requirements for perfect combustion, with no unconsumed elements in the flue gases."

Data are given showing the relation of air supply to furnace efficiency in oil-fired boilers. The amount of air required for the complete combustion of the grade of oil used most extensively on the Pacific coast averages about 14 pounds per pound of oil. The average amount of steam required for atomizing in good performance is about 0.3 pound per pound of oil. In general an excess of about 10 per cent over the amount of air required for complete combustion gives the most economical results attainable. The waste of fuel with more excess air than 10 per cent is very great: at 50 per cent it is about 4.67 per cent, and at 100 per cent, about 10.68 per cent, of the oil actually burned. "Under the present systems of firing the amount of CO_2 present in the flue gases is often as low as 4 or 5 per cent. With an ample supply of labor and a careful and scientific adjustment of dampers by hand, the percentage of CO_2 under an ideal and

uniform load can be maintained as high as 13 per cent. With automatic control and under variable load conditions it has been found possible to maintain a high percentage of CO_2 conforming very closely to ideal conditions."

The first improvement over the crude systems of hand firing was made at the plant of the Pacific Railway Company at Los Angeles. A plan was developed for firing 18 boilers, averaging three burners per boiler, with central hand control of oil pressure. "The operator was stationed near the oil pumps, which were run at a practically constant speed. In front of the operator were the oil pressure gauge connecting to oil main and the steam pressure gauge connecting to steam main. The operator's duty was to maintain a uniform steam pressure on the boilers by opening or closing a bleeder valve on the oil pump discharge line, thus increasing or decreasing the pressure in the oil main, and simultaneously the rate of firing of all of the boilers. The operating crew of the boiler room for each shift consisted of one operator controlling the oil pressure and one water tender, which is probably the record to date for the minimum of boiler room labor for any plant of this size. It was a simple matter to substitute automatic regulation for hand control, following which the writer conceived the idea of utilizing this variation in oil pressure as a secondary means for controlling the supply of steam to burners and the air supply for combustion."

The system is known as the Moore-Patent automatic fuel oil regulating system. It controls the supply of oil to all burners, the supply of steam to all burners and the supply of air for combustion, for any number of boilers, all from a central point. All individual burner valves, both steam and oil, are opened wide or nearly so, and all burners are operated under full pressure in the respective mains. In the larger plants all dampers are connected to a common rock shaft and move simultaneously.

"A slight variation in the steam pressure on the boilers, due to any variation in the demand for steam, is the primary means of control for a steam regulator or governor which varies the oil pressure at the oil pumps and in the oil main. Corresponding to an increased pressure in the oil main, there is an increase in the amount of oil fired and a rise in boiler steam pressure; and corresponding to a decrease of pressure in the oil main, there is a decrease in the rate of oil fired and a lowering of the boiler steam pressure; this regulator thus maintains a uniform steam pressure on boilers at all loads within the governing limits. The variation in pressure in the oil main is the secondary means for controlling the supply of steam for atomizing purposes and also for controlling the supply of air for combustion.

"The supply of steam to burners is controlled by regulating the pressure in a separate low-pressure main common to all burners, the pressure in this main bearing a certain predetermined relationship to the pressure in the oil main and being controlled by a ratio regulator. By means of a specially constructed diaphragm regulator, the opening of the boiler dampers is made to increase or decrease with a corresponding variation of pressure in the oil main, the change in damper opening in turn governing the supply of air for combustion."

Any reliable pump governor may be used to control the oil pressure in the oil main so as to maintain a uniform steam pressure, and it may be used to operate either a throttle in the steam supply or a bleeder valve in the oil discharge pipe. The Spencer damper regulator gives very satisfactory results when the movement of the power lever is used to control a bleeder valve. Regulation of the oil pressure by control of a bleeder valve is more satisfactory than by throttling the steam supply, on account of the liability of the oil pressure to surging due to alternate speeding up and slowing down of the pump in the latter system. The same difficulty exists in a measure in the bleeder-valve system if it is attempted to connect the regulator so as to control the boiler plant automatically through the entire range of load. At the Redondo plant it has been found most economical to limit the automatic regulation to about one-fourth to one-third of the

range of the total variation required, regulation above and below the limits of automatic control being obtained by hand adjustment of the throttle of the oil pump. Except when passing over peak loads it is unnecessary to adjust the throttle more than once every two or three hours, the position of the regulator yard arm indicating when such adjustment is necessary.

Before the development of the regulator for the steam supply, tests were made to determine the relation between the steam required for atomizing oil and the amount of oil burned. It was found that for a variety of burners this relationship could be represented by a straight line, the required steam pressure being equivalent to the product of the oil pressure by a constant, plus a fixed pressure difference. It was, therefore, an easy matter to design a regulator of which the essentials were opposing steam and oil diaphragms of areas or leverages conforming to the observed ratio, and a weight element equivalent to the required difference in pressure. "In the latest development of this regulator the upward pressure is exerted on two diaphragms, one subject to the oil pressure in the oil main, the other to the steam pressure in the low pressure steam main connected to the burners.

"The fulcrum is adjustable for any desired ratio of leverages. The yard arm is counterbalanced at one side, and weighted at the other for the desired weight constant due to the pressure difference factor. Whenever equilibrium is disturbed by variation in oil pressure, the main yard arm will be compelled to move either up or down. This motion is communicated to a water cylinder or motor, such as used on the well known Spencer damper regulator. The movement of the water cylinder in turn operates a suitable lever and connecting rod and finally a rotary chronometer valve, which increases or decreases the supply of steam to the low pressure steam main in such a manner as to restore equilibrium, thereby providing the desired increase or decrease in the steam supply to the atomizers corresponding to the initial change in oil pressure."

Tests were also made previous to the design of the damper controller and it was found that the relationship between variations in the amount of damper opening and variations in the pressure of oil on the burner orifice could be repre sented approximately by a straight line. The regulator finally developed gives an oil supply at all loads but slightly in excess of theoretical requirements. "In this regulator a large diaphragm is subject to upward pressure corresponding to that in the oil main. The motion of the lever is opposed by a coil spring adjustable in position along the lever so as to obtain the required range of motion of the dampers corresponding to the given range of oil pressure. By means of a double-ported controlling valve, connected to the damper controller, the supply of water under pressure is admitted either to the top or the bottom of a hydraulic cylinder connected to the rock shaft. The control is on the principle of the well known differential lever, such as is used in a steering gear, and also common to many types of damper regulators.

"After being once properly adjusted for its entire range of motion, this regulator gives entire satisfaction. It is subject to variation from certain external influences, such as the temperature of the boiler furnace on approaching or receding from peak loads or in starting fires, and variations in the temperature and density of oil. Immediate adjustment and correction for these difficulties can be made by a slight turning of a handwheel on the coil spring, giving a constant change in the amount of opening or closing of all dampers. In actual experience, no adjustment of the damper controller has been necessary except at intervals of three or four hours, depending on the nature of the load carried, the frequency of peaks, etc."

The whole system has proved reliable in service and has resulted in a considerably higher economy than could be obtained with hand control. It is believed that a modification of the system would yield readily to the requirements of boiler plants using natural gas as fuel.

SULPHURIC ACID AS A BY-PRODUCT IN COPPER SMELTING.

THE UTILIZATION OF SULPHUR DIOXIDE FUMES BY THE TENNESSEE COPPER COMPANY.

John Sharshall Grasty—Manufacturers' Record.

THE destruction of vegetation by sulphur dioxide fumes in the neighborhood of copper smelting plants has led within recent years to a number of important legal actions to compel smelting companies to devise means of preventing the escape of noxious furnace gases into the atmosphere. A decision of the Supreme Court against the Tennessee Copper Company and the Ducktown Copper, Sulphur and Iron Company has resulted in the development by these two concerns of a process for the production of sulphuric acid from waste gases which in the case of the former company has given complete success and in connection with which a large fertilizer industry is to be established by a subsidiary of the smelting company. The following details of the production of sulphuric acid and the plans for the new fertilizer industry are taken from an article by Dr. John Sharshall Grasty in the *Manufacturers' Record* for January 7.

Construction work on the plant of the Tennessee Copper Company was begun in 1906. It was put in service about December 1, 1907, and has been in practically continuous operation ever since. The plant of the Ducktown Copper Company is now under construction and will be completed during the spring of the present year. The capacity of the latter plant will be about 320 tons per day. The present capacity of the Tennessee Copper Company's plant is 500 tons per day but this is to be doubled in the near future.

The Ducktown Copper Company experimented for some time with the contact method of manufacture of sulphuric acid but found it unsatisfactory. The lead-chamber process has been adopted for the plant now under construction. This is the process used by the Tennessee Copper Company. In its essential features the plant for the utilization of furnace gases is similar to the ordinary plants of the lead-chamber type, the main difference being the source of gas supply, which in this case is drawn from the concrete flue back of the blast furnaces. Although sulphur dioxide is the predominating gas in the flue gases, sulphur trioxide, carbon dioxide, oxygen and nitrogen are present in sufficient quantities to necessitate the provision of special methods of control for the supply of a suitable gas. The present Tennessee Company plant consists of two Glover towers, 12 chambers and four Gay-Lussac towers. The most serious difficulty met with in operation has been the failure of the original blast-furnace taps, due to the excessive heat to which they were subjected under the method of operation best suited to the acid plant. Changes in the furnaces which are expected entirely to remove this difficulty are now being made.

For the consumption of the sulphuric acid, interests connected with the Tennessee Copper Company have organized a subsidiary concern, known as the Independent Fertilizer Company, for the manufacture of artificial fertilizers. This company has acquired, it is said, a large number of the phosphate deposits from Maryland to Florida and has also come into possession of some of the larger deposits of Germany. It is rumored that Herman Schmidtmann, the phosphate king of Germany, is to be president of the new company. The sulphuric acid will be shipped from the smelter of the Tennessee Copper Company to various points in the south for the manufacture of acid phosphates. It is probable that the Ducktown Copper Company will follow the example of the Tennessee Company and organize a similar fertilizer company as soon as its acid plant is put in operation. The industry promises to be extremely profitable, and with an output of 1320 tons of acid per day the district should soon become one of the most important centres for the production of sulphuric acid and acid fertilizers in the world.

THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE"

The following pages form a descriptive index to the important articles of permanent value published currently in about two-hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

Civil Engineering	865	Mechanical Engineering	881
Electrical Engineering	873	Mining and Metallurgy	892
Industrial Economy	879	Railway Engineering	899
Marine and Naval Engineering	880	Street and Electric Railways	902

CIVIL ENGINEERING

BRIDGES.

Bascule.

A Heavy Strauss Bascule Bridge. Illustrated description of the double-track, single-leaf bascule over the Chicago River for the C. & N. W. Ry. 600 w. Ir Age—Dec. 17, 1908. No. 1035.

The Weights and Costs of Eight Lift Bridges. Data for a guide in making estimates. 1000 w. Engng-Con—Dec. 2, 1908. No. 803.

Blackwell's Island.

The Blackwell's Island Bridge Blunder. Editorial criticism. 2500 w. Engng-Con—Nov. 25, 1908. No. 711.

The Safety of the Blackwell's Island Bridge. Editorial discussion of the reports on the condition of this structure. 2000 w. Engng—Nov. 27, 1908. No. 867 A.

Drawbridges.

The Temporary Bridge Across the Cornwall Canal and the Permanent Repairs to the Canal Break. Describes a temporary drawbridge at Cornwall, Ont., having many interesting features, and also the permanent work on the canal. Ills. 2000 w. Eng News—Dec. 17, 1908. No. 982.

Floors.

Railway Bridge Floors—Old and New.

We supply copies of these articles. See page 904.

Conrad Gribble. An illustrated account of progress in the development of the floor systems of bridges. 5800 w. Cassier's Mag—Dec., 1908. No. 952 B.

Foundations.

Methods and Costs of Testing for Bridge Foundations. F. H. Bainbridge. General considerations, discussing the value of borings. Ills. 2000 w. Engng-Con—Nov. 25, 1908. No. 712.

Junction Curves.

A Note on Some Junction Curves (Note sur diverses Courbes de Raccordement). M. Auric. Shows the solution of several problems which arose during the construction of a bridge over the Rhone. Ills. 3000 w. Ann des Ponts et Chauss—1908 IV. No. 1309 E + F.

Manhattan.

See Suspension Cables, under BRIDGES.

Reinforced Concrete.

Lynhurst Bridge. A. Gillies. Illustrated description of a reinforced concrete span of 116 feet, built in St. Thomas, Canada. 1200 w. Can Engr—Dec. 4, 1908. No. 842.

The Gmünder Bridge, Switzerland (Die Gmünder Tobel-Brücke bei Teufen, Schweiz). A Sutter. Illustrated description of design and construction of this reinforced concrete arch of 79 metres span. Serial. 1st part. 1200 w. Deutsche Bau—Nov. 7, 1908. No. 1156 B.

See also Steel, under BRIDGES.

Steel.

The Protection of Steel Bridges (Sulla Conservazione die Ponti in Ferro). Discusses the problems of corrosion and protective coatings. Serial. 1st part. 3000 w. Ing Ferro—Nov. 1, 1908. No. 1138 D.

The Pitch of Rivets in Built-Up Girders (Ueber Nietteilung in Blechträgern). G. Kapsch. A mathematical discussion. Ills. 3000 w. Oest Wochenschr f d Oeff Baudienst—Nov. 7, 1908. No. 1181 D.

The City's Giant Bridges. Illustrated descriptions of the four large bridges crossing the East River at New York. 3500 w. Sci Am—Dec. 5, 1908. No. 813.

Steel Arch Bridge at Scranton, Pa. Illustrated description of a three-span bridge with reinforced concrete superstructure, massive steel pier columns filled with concrete and two lines of riveted deck trusses supporting a reinforced concrete floor. 2000 w. Eng Rec—Dec. 12, 1908. No. 959.

The McKeesport & Port Vue Bridge. Illustrated detailed description of this highway bridge across the Youghiogheny River. It has a steel superstructure and concrete floor. 1200 w. Eng Rec—Nov. 28, 1908. No. 692.

The Mercantile Bridge across the Monongahela River. Illustrated detailed description of a bridge 1857½ ft. long between abutments and a clear height of 54 ft. 1500 w. Eng Rec—Dec. 19, 1908. No. 1054.

Reconstruction of the Caledonian Railway Bridge, Stirling. Illustrated detailed description of recently completed work on a bridge over the River Forth. 1800 w. Engng—Dec. 4, 1908. Serial. 1st part. No. 1017 A.

Some Railway Bridges on the West Coast of Tasmania. James Bannatyne Lewis. Illustrates and describes the erection of bridges with limited resources. 3000 w. Inst of Civ Engrs—No. 3710. No. 888 N.

See also Bascule, Drawbridges and Junction Curves, under BRIDGES.

Suspension Cables.

Construction of the Manhattan Bridge Cables. Illustrates and describes methods used. 4000 w. Eng Rec—Dec. 5, 1908. No. 830.

CONSTRUCTION.

Boring.

Methods and Costs of Making Wash Borings on a Ship Canal Survey. A. W. Saunders. Illustrates the drills used and gives a report of the difficulties encountered. 1000 w. Engng Con—Dec. 9, 1908. No. 923.

See also Foundations, under BRIDGES.

Concrete.

The Relation of Temperature to the Removal of Concrete Forms. Editorial on the need of tests to establish some scientific basis for form removal. 900 w. Eng News—Dec. 3, 1908. No. 774.

Uses of Concrete on a Country Estate. Linn White. An illustrated article showing its architectural possibilities. 4000 w. Sci Am Sup—Dec. 26, 1908. No. 1296.

See also Regulations, under CONSTRUCTION.

Contractor's Plants.

The Contractor's Plant for Building a Triple Barrel Reinforced Concrete Sewer. Illustrates and describes the plant for building a reinforced concrete sewer on pile foundations, mostly over a marsh, in the Bronx, New York City. 2800 w. Eng. Rec—Nov. 28, 1908. No. 700.

Excavation.

Handling the Excavation and Concrete Materials for a Large Steel-Cage Building. Illustrates and describes methods used in the most congested district of Chicago. 2800 w. Eng Rec—Nov. 28, 1908. No. 693.

See also Rock Removal, under WATERWAYS AND HARBORS.

Fireproof.

Fire Tests of Concrete and Terra Cotta Tile. A comparison of the fireproof properties of the two materials as disclosed by recent fires. Ills. 3300 w. Cement Age—Dec. 1908. No. 1318.

We supply copies of these articles. See page 904.

Status of Reinforced Concrete from the Fireproof Standpoint. Emile G. Perrot. On the behavior, economy and efficiency of concrete, its proper construction, etc. Ills. 1800 w. Cement Age. Dec., 1908. No. 1319.

Floors.

Concrete Floor Construction. Illustrated description of a modern method of treating concrete as lumber—the Vaughan System of portable concrete joists. 1500 w. Cement Age—Dec., 1908. No. 1320.

Suspended Reinforced-Concrete Floors in the Grand Hôtel Royal, Lausanne (Planchers suspendus en Béton armé au Grand Hôtel Royal, a Lausanne). A. Paris. Illustrated description of their design and construction. 1400 w. Bul Tech d l Suisse Romande—Nov. 10, 1908. No. 1117 D.

Foundations.

Foundations for the New Singer Building, New York City. Discussion of the paper by T. Kennard Thomson. Ills. 2000 w. Pro Am Soc of Civ Engrs—Dec., 1908. No. 1356 E.

See also Excavation, under CONSTRUCTION.

Graphical Statics.

The Deflection Polygon of a Framed Structure as a Funicular Polygon. Myron S. Falk. Mathematical. 800 w. Sch of Mines Qr—Nov., 1908. No. 973 D.

High Buildings.

Tall Buildings of New York. Illustrations and information concerning some of the lofty office buildings recently erected. 2500 w. Sci Am—Dec. 5, 1908. No. 814.

Piling.

Shop-Made Reinforced-Concrete Piles. L. J. Mensch. Illustrates and describes work carried out at Oakland, Cal. 1200 w. Eng News—Dec. 3, 1908. No. 775.

Regulations.

General Regulations for the Preparation, Execution and Testing of Rammed Concrete Construction (Allgemeine Bestimmungen für die Vorbereitung, Ausführung und Prufung von Bauten aus Stampfbeton). An abstract and a discussion of the regulations adopted by the German Reinforced Concrete Commission. 4000 w. Beton u Eisen—Nov. 20, 1908. No. 1177 F.

Reinforced Concrete.

The Principles and Resources of Reinforced Concrete Construction (Le Béton armé actuel, ses Principes et ses Ressources). Charles Rabut. A general review. 3000 w. Ann d Ponts et Chauss—1908-IV. No. 1313 E + F.

The Employment of Reinforced Concrete Beams according to the Regulations of the Italian Government (Il Calcolo delle Travi inflesse in Cemento armato secondo le Normi Ministeriali Italiane). Mathematical. Ills. Serial. 1st part. 4000 w. Il Cemento—Oct., 1908. No. 1137 D.

Bending Moments in Continuous Reinforced Concrete Beam. A discussion by O. Gottschaer, in *Beton u. Eisen*, of the bending moments in a continuous beam over 3 supports, especially at the mid support. 1000 w. Cement—Nov., 1908 No. 899 C.

The Manufacture, Erection and Demolition of Forms for Concrete Work. Francis W. Wilson. A criticism of method generally used for the manufacture and erection of form work with discussion of an improved system. 3000 w. Eng News—Dec. 17, 1908. No. 980.

A Novel System of Concrete Construction. Day Allen Willey. Illustrated description of methods of construction at Camp Perry, Ohio. 1400 w. Sci Am—Dec. 26, 1908. No. 1293.

The Employment of Reinforced Concrete in Public Works (L'Emploi du Béton Armé dans les Travaux publics). M. G. Espitallier. Reviews its many uses, in the construction of dams, breakwaters, foundations, piles, etc. Ills. 11000 w. Mem Soc Ing Civ de France—Oct., 1908. No. 1305 G.

See also Contractors Plants, Fireproof, Floors, and Piling, under CONSTRUCTION; Sewage Tanks and Sewers, under MUNICIPAL; Dams, Pipes and Water Towers, under WATER SUPPLY; Refrigeration, under MECHANICAL ENGINEERING, HEATING AND COOLING; and Flat Plates, under MECHANICAL ENGINEERING, MACHINE ELEMENTS AND DESIGN.

Retaining Walls.

A Large Retaining Wall at Tacoma, Louis P. Zimmerman. Brief illustrated description of one of the largest concrete retaining walls on the Pacific Coast. 1000 w. Eng Rec—Nov. 28, 1908. No. 697.

Stacks.

The Chimney of the Boston & Montana Consolidated Copper & Silver Mining Company. Illustrated detailed description of the largest and highest chimney in the world, and its construction. 5500 w. Eng Rec—Nov. 28, 1908. No. 691.

Steel.

Special Structural Steel Work in the La Salle Hotel, Chicago. Illustrates and describes special features in steel framing. 2200 w. Eng News—Dec. 3, 1908. No. 773.

Structural Details in the New Theatre, New York. Illustrated detailed description of floor girders, roof trusses, and other details. 2800 w. Eng Rec—Dec. 26, 1908. No. 1246.

Structural Details of the Carnegie Technical School, Pittsburgh. Illustrates and describes details of steel cage construction. 1600 w. Eng Rec—Dec. 5, 1908. No. 833.

We supply copies of these articles. See page 904.

Raising and Strengthening the Oversea Platforms of a Coaling Station at St. Vincent. Walter Sidney Harvey. Describes the construction of this coaling station on the Cape Verde Islands, and recent repairs. Ills. 2500 w. Inst of Civ Engrs—No. 3731. No. 886 N.

See also Water Towers, under WATER SUPPLY; and Docks, under WATERWAYS AND HARBORS.

Swimming Pools.

The Swimming Pool for the University of Minnesota. F. H. Constant. Illustrated description of a pool costing about $7,000, under construction. 2000 w. Minn Engr—Nov., 1908. No. 1359 C.

Tunnels.

Tunnels and Subways. Illustrations and information in regard to these interesting engineering works in New York City and some of the difficulties met. 3000 w. Sci Am—Dec. 5, 1908. No. 815.

Records of Driving Rock Tunnels and Some Comment on the High Cost of the Elizabeth Tunnel. Information relating to work on the tunnel that is to carry the waters of the Los Angeles aqueduct through the Coast Range. 1200 w. Engng Con—Dec. 9, 1908. No. 922.

The Reconstruction of a Portion of the Cwm Cerwyn Tunnel. Illustrates and describes method of reconstructing 180 ft. of a tunnel on the Port Talbot Railway, in South Wales, without interference of traffic. 2000 w. Engr, Lond—Dec. 4, 1908. No. 1022 A.

Waterproofing.

See Refrigeration, under MECHANICAL ENGINEERING, HEATING AND COOLING.

MATERIALS OF CONSTRUCTION.

Cement.

The Association of German Portland Cement Manufacturers; Summary of Proceedings for 1908. New German Cement Specifications. Robert W. Lesley and E. W. Lazell. Portion of a paper read before the Assn. of Am. Portland Cement Mfrs. 2000 w. Eng News—Dec. 24, 1908. No. 1239.

See also same title, under MINING AND METALLURGY, MINOR MINERALS.

Concrete.

Tests on the Effect of Electric Current on Concrete. U. James Nichols. Abstract of a paper presented for a degree at the Mass. Inst. of Tech. A report of the experimental work. Also editorial. 4500 w. Eng News—Dec. 24, 1908. No. 1237.

See also Concrete, under CONSTRUCTION; and Reinforced Concrete, under MATERIALS OF CONSTRUCTION.

Paints.

Rust Proof Coating for Steel. William Elsberg. Brief account of the process invented by George A. Goodson. Ills. 1200 w. Minn Engr—Nov., 1908. No. 1360 C.

Reinforced Concrete.

The Composition and Uses of Plain and Reinforced Concrete. Charles F. Marsh. Read before the Concrete Inst. Briefly discusses the mixing, aggregates, waterproofing, nature of reinforcement, etc. 2000 w. Surveyor—Nov. 20, 1908. No. 728 A.

Steel.

Nickel Steel for Bridges. Discussion of paper by J. A. L. Waddell. 6000 w. Pro. Am Soc of Civ Engrs—Dec., 1908. No 1357 E.

Steel Corrosion.

See Steel, under BRIDGES.

Terra Cotta.

See Fireproof, under CONSTRUCTION.

Timber.

An Analysis of Canada's Timber Wealth. Abstract of a study by B. E. Fernow. Information concerning the timber areas and their value. 5500 w. Can Engr—Dec. 4, 1908. No. 843.

Timber Preservation.

Preservation of Timber. F. H. Mason. General remarks, with details of the creosoting plant at Norfolk, Virginia. 4500 w. Min & Sci Pr—Dec. 19, 1908. No. 1260.

MEASUREMENT.

Surveying.

A New Precise Measurement Method with Special Line Clinometers and Tape Stretchers. Describes a method of measurement and novel instruments used. 1500 w. Eng News—Dec. 24, 1908. No. 1240.

The Rectangular System of Surveying. W. A. Truesdale. Information in regard to the development of this system. 9000 w. Jour Assn of Engng Socs—Nov., 1908. No. 1342 C.

Staking Out Curves in Rough Ground. Robert Laird. Read before the Ontario Land Surveyors' Convention. Explains method used. 2000 w. Engng-Con—Nov. 25, 1908. No. 713.

Telemeter.

A Telemeter with Micrometer Screw Adjustment. Fred Eugene Wright. Describes a simple, fairly accurate instrument. 1200 w. Am Jour of Sci—Dec., 1908. No. 777 D.

Testing Laboratories.

See same title, under MECHANICAL ENGINEERING, MEASUREMENT.

MUNICIPAL.

Drainage.

Hydraulic Diagrams. D. D. Bleich. Presents data and diagrams to facilitate computations of run-off and pipe flow. 2500 w. Sch of Mines Qr—Nov., 1908. No. 974 D.

We supply copies of these articles. See page 904.

Municipal Engineers.

The Municipal Engineer: His Duties and Responsibilities. F. J. Edge. Presidential address before the Newcastle-on-Tyne Assn. of Students of the Inst. of Civil Engrs. 3500 w. Surveyor—Nov. 20, 1908. No. 729 A.

Pavements.

Roads and Streets. Louis C. Kelsey. Reviews briefly the various pavements used, their construction and maintenance. 2500 w. Jour Assn of Engng Socs—Oct., 1908. No. 782 C.

Old and New Methods of Asphalt Paving. Guy B. Grant. A comparison of work done in Omaha, Neb., in 1882, with present-day methods. 2000 w. Munic Engng—Dec., 1908. No. 785 C.

The Value of Carbene Requirement in Asphalt Specifications. L. Kirschbaum. An investigation made to determine the value of the carbene test. 2000 w. Munic Engng—Dec., 1908. No. 784 C.

The Mineral Rubber Pavement. Linn White. Read before the Am. Soc. of Munic. Imp. Describes this form of pavement and states the advantages claimed for it. 2000 w. Munic Engng—Dec., 1908. No. 787 C.

The Blome Concrete Pavement. Harry S. Dewey. Read before the Am. Soc. of Munic. Imp. Describes this system of granitoid concrete blocked pavement. 2200 w. Munic Engng—Dec., 1908. No. 786 G.

Roads.

Effect of the Road Surface on Vehicles. C. S. Rolls. Read before the Int. Road Cong. Discusses improvements that would increase the life of the vehicle and the comfort of passengers. 1200 w. Surveyor—Dec. 4, 1908. No. 1012 A.

Improvements in Self-Propelled Vehicles for the Reduction of Road Wear. Col. R. E. Crompton. Read before the Int. Road Cong. Discusses some points in regard to their effect on roads, such as steel studded tires, diameter of driving wheels, etc. 1200 w. Surveyor—Nov. 20, 1908. No. 727 A.

Roads for Heavy Traffic. H. P. Maybury. Read before the Int. Road Cong. An account of work in the County of Kent, England. 1200 w. Eng Rec—Nov. 28, 1908. No. 699.

Examination of Tars for Use on Roads. Clayton Beadle and Henry P. Stevens. An experimental study with a view to determining the advantages of the different grades. 3000 w. Surveyor—Dec. 4, 1908. No. 1014 A.

Macadam Road Surfacing. Walter Wilson Crosby. Read before the Paris Int. Road Cong. Discusses the proper construction of macadam roads to meet present conditions. 2500 w. Surveyor—Nov. 27, 1908. No. 850 A.

General Figures in the Cost of Road Construction in Various Parts of the United States. Information from a report submitted by Maurice O. Eldridge to the Int. Road Congress at Paris, France. 2500 w. Engng Con—Dec. 23, 1908. No. 1290.

Road Construction and Maintenance in Gloucester County, England. Robert Phillips. Presented at the Int. Road Cong. Gives results of the experience of the writer. 3500 w. Engng-Con—Dec. 16, 1908. No. 1076.

Road Maintenance in France and Ireland. R. H. Dorman. Read before the Int. Road Cong. A comparison of roads and methods in the two countries, and suggests alterations that should be made in Irish laws relating to road maintenance. 1800 w. Surveyor—Dec. 4, 1908. No. 1011 A.

Systems of Highway Administration Compared: Their Influence on Cost and Efficiency. W. Rees Jeffreys. A comparative examination of the highway systems in the principal countries. 3000 w. Surveyor—Dec. 11, 1908. Serial. 1st part. No. 1202 A.

Sewage Disposal.

The Administrative Aspects of Sewage Disposal. Herbert T. Scoble. Paper read before the Surveyors' Inst. 7000 w. Surveyor—Nov. 27, 1908. No. 851 A.

The Hampton Doctrine in Relation to Sewage Purification. Dr. A. Lübbert. Trans. from the German. Discusses a paper by W. Owen Travis, showing that the Hampton doctrine cannot exist along with Dunbar's absorption theory. 3000 w. Surveyor—Dec. 4, 1908. Serial. 1st part. No. 1013 A.

The Hampton Doctrine in Relation to Sewage Purification. W. Owen Travis. Reply to the criticisms of Dr. A. Lübbert. 3500 w. Surveyor—Dec. 18, 1908. Serial, 1st part. No. 1385 A.

Some Observations of Methods, Cost and Results of Sewage Purification Abroad. H. W. Clark. Discusses the kind of sewage plants that are being built and operated in England and elsewhere, and matters relating to them. General discussion. Ills. 14000 w. Jour Assn of Engng Socs—Nov., 1908. No. 1343 C.

On Percolation Beds. William Clifford. An account of experiments relating to the physical conditions obtaining in sewage filter-beds, with special reference to percolation beds. 4500 w. Inst of Civ Engrs—No. 3751. No. 883 N.

Experimental Treatment of Effluents of Sprinkling Sewage Filters. Notes from the annual report of the Massachusetts Board of Health on the results of experiments made at the Lawrence Experiment Station. 1700 w. Eng Rec—Nov. 28, 1908. No. 696.

The Lawrence Experiments Regarding the Distribution of Sewage over Sprink-

We supply copies of these articles. See page 904.

ling Filters. From the report of H. W. Clark describing the researches of the Massachusetts Board of Health. 6000 w. Eng Rec—Dec. 26, 1908. No. 1247.

An Unhampered Cesspool—A True Short Story of Domestic Sanitation. Robert Fletcher. Describes the conditions and discusses the principles for a small disposal plant. 2200 w. Eng News—Dec. 17, 1908. No. 986.

The Application of Small-Scale Biological Purification (Le Applicazioni della Depurazione biologia agli Edifici isolati). Illustrates and describes various systems of sewage treatment for isolated houses. 4200 w. Monit Tech—Nov. 20, 1908. No. 1136 D.

A Scientific Scheme for Sewage Disposal by Dilution in New York Harbor. Editorial discussion of the plan of the Passaic Valley Sewerage District, and the discharge of sewage into New York harbor. 2000 w. Eng News—Dec. 17, 1908. No. 984.

Sewage Pumping.

See Pumping Plants, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Sewage Tanks.

A Concrete Sewage Tank Reinforced Against External Pressure. Explains conditions and gives an illustrated description of the storage tank. 1500 w. Eng Rec—Dec. 19, 1908. No. 1056.

Sewers.

Sewer Construction in Chicago. Illustrated description of the concrete sewer work of the Ninety-fifth Street system. 3000 w. Munic Jour & Engr—Dec. 2, 1908. No. 748 A.

Some Details of the Design and Construction of the Baltimore Sewerage System. Illustrates and describes the outfall sewer, siphon culvert, weir in force main sewer and other details. 3000 w. Eng Rec—Dec. 19, 1908. No. 1059.

The New Sewerage System of Baltimore, Md. Explains the problems and describes the system. Ills. 3500 w. Eng Rec—Dec. 5, 1908. No. 834.

Street Cleaning.

The Automobile in Street Cleaning (Der automobile Antrieb für Zwecke Strassenreinigung). D. Nier. Gives comparative cost of street sprinkling with horse-drawn and self-propelled sprinklers. 2500 w. Gesundheits-Ing—Nov. 7, 1908. No. 1170 D.

WATER SUPPLY.

Analysis.

The Determination of Carbohic Acid in Water (Beitrag zur Bestimmung der Kohlensäure im Wasser). Dr. F. Guth. A discussion of the various methods. 6000 w. Gesundheits-Ing—Nov. 21, 1908. No. 1172D.

Croton.

Development of the Croton Watershed. An illustrated review of the system of reservoirs developed in the valley of the Croton River for the supply of New York City. 3000 w. Sci Am—Dec. 5, 1908. No. 812.

Dams.

Experimental Investigations of the Stresses in Masonry Dams Subjected to Water Pressure. Paper 3674, by Sir John Walter Ottley and Arthur William Brightmore; Paper 3705, by John Sigismund Wilson and William Gore; Paper 3583, by Ernest Prescot Hill, discussed together. Also correspondence. Plates. 50000 w. Inst of Civ Engrs—No. 889 N.

A Successful Low Timber Dam for Broad, Sandy River Channels. O. K. Parker. Illustrations, with description of methods of construction. 1200 w. Eng Rec—Dec. 5, 1908. No. 832.

Economical application of Water Power in Tasmania. James B. Lewis. Gives the cost and method of construction of dams. 2000 w. Aust Min Stand—Nov. 18, 1908. No. 1093 B.

A Report on the Foundations and Construction of the Gatun Dam. From the recent report of C. M. Saville giving results of the investigations. 1200 w. Eng News—Dec. 24, 1908. No. 1241.

Experimental Hydraulic-Dredge-Fill Dams at Gatun, made for the Isthmian Canal Commission. C. M. Saville. From Appendix E, Report of the Isthmian Canal Commission. Illustrated description. 6500 w. Eng News—Dec. 24, 1908. No. 1242.

Reconstruction of the Roanne Water-Supply Dam (Reconstruction du Barrage de Prise d'Eau en Loire à Roanne). M. Mazoyer. Describes reinforced-concrete caisson construction. Ills. 6500 w. Ann d Ponts et Chauss—1908-IV. No. 1310 E + F.

Fish Ways in Dams (Fischwege in Stauanlagen). Dr. H. Löschner. A practical discussion of their arrangement. Ills. 3300 w. Oest Wochenschr f d Oeff Baudienst—Nov. 14, 1908. No. 1182 D.

The Caméré System of Fish Ways installed in the Dams of the Rivers l'Hyères and l'Aulne (Note sur les Echelles à Poissons du Système Caméré établies aux Barrages verticaux des Rivières l'Hyères et l'Aulne). M. le Guillier. Illustrated description. Plate. 3000 w. Ann d Ponts et Chauss—1908-IV. No. 1312 E + F.

Discharge Coefficients.

On Coefficients of Discharge Through Sluice-Gates and over Weirs. H. F. Labelle. Gives results of experimental investigations, especially those of Prof. Chatterton, on the Kistna River, India. 2500 w. Eng Rec—Dec. 26, 1908. No. 1249.

We supply copies of these articles: See page 904.

Dover, England.

The Dover Watershed and Water Supply. Henry Edward Stilgoe. Describes the physical features of this watershed with a view to ascertain where the largest supplies may be obtained. Plates. 5000 w. Inst of Civ Engrs—No. 3730. No. 884 N.

Fish Ways.

See Dams, under WATER SUPPLY.

Irrigation.

See Meters, under WATER SUPPLY.

Meters.

Automatic Devices for Measuring Water used for Irrigation. F. W. Hanna. A summary of the methods most generally in use and discussion of some of the best American devices invented for this purpose. 3000 w. Eng News—Dec. 17, 1908. No. 981.

Newton, Mass.

Newton's Water Supply System. A. W. King. Illustrates and describes a supply in Massachusetts of underground water obtained through pipe wells. 200 w. Munic Jour & Engr—Dec. 23, 1908. No. 1069.

Pennsylvania.

The Quality of Some Pennsylvania Waters. R. B. Dole. Read before the Eastern Ice Assn. Presents results of recent investigations into the mineral composition of the large rivers. 2500 w. Ice & Refrig—Dec., 1908. No. 996 C.

Pipe Flow.

See Drainage, under MUNICIPAL.

Pipes.

Reinforced Concrete Pipe with Reinforced Joint. Illustrated description of a reinforcement utilized also for making the joint between lengths. 700 w. Eng News —Dec. 10, 1908. No. 941.

Purification.

The Purification of Ground Waters Containing Iron and Manganese. Robert Spurr Weston. Considers the theory and practice of the iron-removal process in use in Europe and America. 18500 w. Pro Am Soc of Civ Engrs—Dec., 1908. No. 1353 E.

The Purification of Bubbly Creek, Chicago Stock Yards. A summary of the report by George A. Johnson of tests made of the filter plant for purifying the water. Ills. 4500 w. Eng Rec—Dec. 12, 1908. Serial. 1st part. No. 955.

The Results of an Examination of the Water Purification Plant at Marietta, Ohio. Philip Burgess gives a description of the plant and its operation, with report of its examination and the recommendations. 4000 w. Eng Rec—Dec. 19, 1908. No. 1058.

Notes Concerning the Water Purification Plant now under Construction for the City of Toledo, Ohio. William G. Clark. Describes the filtration plant. 3000 w. Ohio Soc of Mech Elec & Steam Engrs, No. 142—Nov., 1908. No. 905 N.

The Water Purification Plant at Toledo. William G. Clark. Read before the Ohio Soc. of Mech., Elec. & Steam Engrs. Describes methods used to purify the river water. 3000 w. Eng Rec—Nov. 28, 1908. No. 695.

An Ozone Purification Plant at Chartres (Usine de Clarification et d'Ozonation des Eaux de la Ville de Chartres). Augustin Witzig. Illustrated description of a plant serving a city of 23,000 inhabitants. 1000 w. Génie Civil—Nov. 28, 1908. No. 1126 D.

Rates.

See Water Works, under WATER SUPPLY.

Reservoirs.

The Construction of the Croton Falls Reservoir. Describes new features and methods developed in the course of recent work on this great reservoir for the supply of New York City. 4500 w. Eng Rec—Dec. 12, 1908. No. 961.

See also Croton, under WATER SUPPLY.

Softening.

See Locomotive Feed Water, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Springfield, Mass.

The Construction of the Little River Water Supply for Springfield, Mass. Illustrated description of important features of work now in progress, including intake dam and tunnel, filter plant and settling basin; reservoirs, pipe lines, etc. 5500 w. Eng Rec—Dec. 12, 1908. No. 954.

Water Towers.

The Steel and Concrete Water Tower at Grand Rapids, Mich. Illustrated detailed description of a 885,000-gal. water tower recently erected. 2000 w. Eng Rec—Dec. 12, 1908. No. 956.

Water Works.

Montreal Water-Works Improvements. Map and illustrated description of work in progress. 1200 w. Engr, London—Dec. 11, 1908. No. 1220 A.

Water-Works Valuation and Fair Rates, in the light of the Main Supreme Court Decisions in the Waterville and Brunswick Cases. Discussion of paper by Leonard Metcalf on this subject. 3500 w. Pro Am Soc of Civ Engrs—Dec., 1908. No. 1355 E.

Weirs.

A Segmental Rolling Weir built in 1886 on the Rhone Canal at Cette (Note sur un Système de Fermeture à Segment exécuté en 1886-87 sur le Canal du Rhone à Cette). M. Guibal. Illustrated description. 5600 w. Ann d Ponts et Chauss—1908-IV. No. 1311 E + F.

We supply copies of these articles. See page 904.

Rolling Weir and Hydro-Electric Plant of the Lauffen Portland Cement Works at Neckarwestheim, Württemberg (Das Walzenwehr und die Wasserkraftanlage des Württembergischen Portlandzementwerkes Lauffen bei Neckarwestheim am Neckar). Herr Nauffer. Gives some details of all the weirs of this type in existence and describes this special installation. Ills. 4400 w. Zeitschr d Ver Deutscher Ing—Nov. 21, 1908. No. 1194 D.

Wells.

See Newton, Mass., under WATER SUPPLY.

Youngstown, O.

An Industrial Water Supply for the Youngstown District. Explains conditions and illustrates and describes the project carried out which will impound two billion gallons in three lakes, giving a head of 160 feet. 1800 w. Ir Trd Rev—Dec. 17, 1908 No. 1037.

WATERWAYS AND HARBORS.

Antwerp.

The Antwerp Harbor Works (Note sur les Travaux du Port d'Anvers). A Alby. Illustrated description of recent work. 5300 w. Mem Soc Ing Civ de France—Oct., 1908. No. 1306 G.

Barcelona.

The Port of Barcelona (Le Port de Barcelone). M. Batard Razelière. Discusses its status, works in progress and projected, administration, facilities for handling freight, etc. Ills. 26000 w. Ann des Ponts et Chauss—1908-IV. No. 1308 E + F.

Canal Haulage.

See same title, under STREET AND ELECTRIC RAILWAYS.

Canals.

The Relation of Railways to Canals. John F. Stevens. Extract from a paper read before the Atlantic Deeper Waterways Assn. Gives arguments favoring a canal system constructed by the National Government. 1200 w. Eng News—Dec. 10, 1908. No. 938.

See also Drawbridges, under BRIDGES.

Detroit River.

The Improvement of the Detroit River for Navigation. Map and illustrated description of work in progress. 4000 w. Eng News—Dec. 17, 1908. No. 979.

Docks.

Harbor and Dock Improvements. Illustrates and describes recent work at the port of New York. 1000 w. Sci Am—Dec. 5, 1908. No. 816.

New Colman Dock at Seattle. H. Cole Estep. Illustrated description of a new dock 700 ft. long, costing about $1,000,000. 2000 w. Marine Rev—Dec. 3, 1908. No. 822.

A Structural-Steel Ore Dock at Two Harbors, Minn. Illustrated detailed description of a 50000-ton ore dock, the first of its kind to be erected in the United States. 2200 w. Eng Rec—Dec. 5, 1908. No. 831.

Keyham Dockyard Extension. Sir Whately Eliot. Brief review of the history of this dockyard, with illustrated description of works constructed since 1896. Keyham Dockyard and Extension; Temporary Works, and Plant and Appliances Used in Construction. George Hall Scott. Two papers discussed together. Plates. 38500 w. Inst of Civ Engr—Papers 3701 & 3728. No. 890 N.

Dredging.

Bucket Dredging and Pump Sluicing. H. Herman. Considers their applicability and costs. 2000 w. Aust Min Stand—Nov. 18, 1908. No. 1096 B.

Fremantle.

The New Fremantle Harbor (Le Nouveau Port de Fremantle). Paul Privat-Deschanel. Describes recent improvements. Map. 1500 w. Génie Civil—Nov. 7, 1908. No. 1120 D.

Georgian Bay Canal.

The Georgian Bay Ship Canal. J. G. G. Kerry. Reviews the history of this project and gives an outline of the projected route. 4000 w. Engineering Magazine—Jan., 1909. No. 1326 B.

Harbors.

The Influence of Recent Developments in Size and Speed of Steamships on Port and Harbour Accommodation. Brysson Cunningham. A discussion of some of the problems affecting modern shipbuilding and port accommodations. Ills. 3500 w. Cassier's Mag—Dec., 1908. No. 950 B.

Locks.

See Cranes, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Ohio River.

Silt in the Proposed Reservoirs of the Ohio Basin. Herman Stabler. Gives estimates of the sediment accumulation and discusses its effect. 3500 w. Eng News—Dec. 10, 1908. No. 943.

The Permanent Improvement of the Ohio River. P. S. Bond. An account of the project undertaken by the United States Government, including a system of locks and movable dams designed to maintain a least depth of 9 feet. 5500 w. Eng Rec—Dec. 26, 1908. Serial. 1st part. No. 1244.

Panama Canal.

Extracts from the Annual Report of the Isthmian Canal Commission. Report of progress of work for year ending June 30, 1908. Ills. 6000 w. Eng News—Dec. 3, 1908. No. 772.

The Commercial Prospects of the Pana-

We supply copies of these articles. See page 904.

ma Canal. G. A. Ballard. An outline of its commercial prospects leading to the conclusion that it is unlikely to prove a commercial success. 5500 w. Contemporary Rev—Dec., 1908. No. 1297 D.

Analysis Showing that the Panama Canal is Certain to Cost at Least $210,000,000, or 50 Per Cent. More Than Originally Estimated. Editorial. 2500 w. Engng-Con—Dec. 2, 1908. No. 802.

The Present Condition of Work on the Panama Canal. An illustrated account of the present situation based on the latest report of Col. George W. Goethals, recent issues of the *Canal Record*, and information from other sources. 9500 w. Eng Rec—Dec. 5, 1908. No. 829.

See also Dams, under WATER SUPPLY; and Cranes, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

River Improvement.

See Detroit River, under WATERWAYS AND HARBORS.

River Regulation.

See Ohio River, under WATERWAYS AND HARBORS.

Rock Removal.

Removal of Submarine Rock at the Entrance to Port Phillip, Victoria. Charles William Maclean. Describes work to provide adequate depth of water for deep-draught vessels entering or leaving the Port of Melbourne. (Abstract) Ills. Inst of Civ Engrs—No. 3545. No. 887 N.

Shore Protection.

River Improvement: The Continuous Woven Mattress Revetment Compared to the David Neale System. A critical letter concerning an article by Charles H. Miller, with reply by Mr. Miller. 5000 w. Eng News—Dec. 10, 1908. No. 942.

Water Powers.

Water Power Possibilities, at Muscle Shoals, on Tennessee River. S. Mays Ball. Map and description of power being developed. 1500 w. Elec World—Dec. 26, 1908. No. 1287.

See also Isolated Plants, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

MISCELLANY.

Strain Models.

Models for Illustrating the Strain on Structures. Dr. Alfred Gradenwitz. Illustrated description of models used by E. Carlipp, of Erlangen, Germany. 1800 w. Sci Am—Dec. 26, 1908. No. 1291.

ELECTRICAL ENGINEERING

COMMUNICATION.

Radio-Telegraphy.

Post-Graduate Lectures on Radiotelegraphy and Radiotelephony. Prof. J. A. Fleming. Brief review of Prof. Fleming's fifth and sixth lectures delivered at University College. 2000 w. Engng—Dec. 4, 1908. No. 1020 A.

Post-Graduate Lectures on Radiotelegraphy and Radiotelephony. J. A. Fleming. Reviews the seventh and eighth lectures on the above subject. 2200 w. Engng—Dec. 18, 1908. No. 1373 A.

The Bolt Head Wireless Telegraph Station of the General Post Office. Illustrated description of this recently opened English station for communicating with ships at sea. 2200 w. Elec Engng—Dec. 17, 1908. No. 1390 A.

Radio-Telephony.

See Radio-Telegraphy, under COMMUNICATION.

Telephone Cables.

New Observation on Long Distance Submarine Cables. F. Breisig. Abstract from *Electrotechnische Zeit.* Describes experience with submarine telephone cables in which the copper conductors are wound for their entire length with fine iron wire. 2000 w. Elect'n, Lond—Nov. 27, 1908. No. 860 A.

Telephone Transmitters.

Raymond Barker's Multi-Tone Vibrating Transmitter. Illustrated description of a novel instrument exhibited at the Physical Society's Exhibition. 1500 w. Elect'n, Lond—Dec. 18, 1908. No. 1394 A.

Telephony.

The Influence of Terminal Apparatus on Telephonic Transmission. Louis Cohen. Discusses this phase of the problem, showing the distortion produced by terminal apparatus, and considering certain improvements. Mathematical. 1500 w. Bul Bureau of Stand—Nov., 1908. No. 1346 N.

See also Communication, under STREET AND ELECTRIC RAILWAYS.

DYNAMOS AND MOTORS.

A. C. Dynamos.

The Parallel Operation of Direct Connected Alternators. A. E. Buchenberg. Discusses the conditions necessary for parallel operation, and the problems in connection. 1500 w. Elec Wld—Dec. 5, 1908. No. 808.

A. C. Motors.

The Current and Output of Alternating Current Motors. Paul C. Percy. Explanation of method of determining the relation between the current and output. 1200 w. Power—Dec. 22, 1908. No. 1078.

The Separation of Stator Losses in Three-Phase Motors by Means of the Hysteresis Angle (Die Trennung der Statorverluste des dreiphasigen Motors durch Ermittlung des Hysteresiswinkels). Hermann Zipp. Describes a simple means of separating the hysteresis and eddy-current losses. Ills. 1600 w. Elektrotech u Maschinenbau—Nov. 8, 1908. No. 1185 D.

D. C. Motors.

Design of a One-Sixth Horse-Power Motor. F. C. Mason. Drawings and description of a motor designed to operate a window display machine. 1200 w. Elec Wld—Dec. 5, 1908. No. 811.

See also Railway Motors, under DYNAMOS AND MOTORS.

Economy.

Output and Economy Limits of Dynamo-Electric Machinery. J. C. Macfarlane and H. Burge. Considers present day practice and the directions in which extensions may be expected. 9500 w. Inst of Elec Engrs—Dec. 10, 1908. No. 1206 N.

Induction Motors.

Magnetizing and Potential Coefficients of Polyphase Windings. R. E. Hellmund. Gives results obtained by the writer's method, with data relating to fractional-pitch windings. 800 w. Elec Wld—Dec. 19, 1908. No. 1269.

Investigation and Determination of the Additional Iron Losses in Induction Motors (Untersuchung und Berechnung der zusätzlichen Eisenverluste in asynchronen Motoren). O. S. Bragstad and A. Fraenckel. Mathematical. Ills. Serial. 1st part. 2100 w. Elektrotech Zeitschr—Nov. 5, 1908. No. 1198 B.

Railway Motors.

Features of Continuous-Current Railway Motor Design. E. V. Pannell. The limiting dimensions for these motors is explained and features discussed. 1500 w. Elec Rev, Lond—Dec. 4, 1908. No. 1007 A.

The Development and Construction of Motors and Driving Gears for Electric Cars (Entwicklung und Beschaffenheit der Triebmotoren und Triebwerke elektrischer Eisenbahnfahrzeuge). Dr. W. Kummer. Ills. Serial. 1st part. 3000 w. Schweiz Bau—Nov. 7, 1908. No. 1157 B.

Regulation.

Shunt Regulation by the "Potential Slide" Method. Thomas Carter. Notes on shunt regulators for motors and dynamos with abnormally high ranges of regulation. 2500 w. Elec Engr, Lond—Nov. 20, 1908. No. 731 A.

Repulsion Motors.

Commutation of the Compensated Series Repulsion Motor. A. R. Dennington. Describes this alternating-current commutator motor, and states the advantages of the arrangement. 2500 w. Elec Wld—Dec. 12, 1908. No. 928.

Alternating Current Commutator Motors. Dr. Rudolf Goldschmidt. Discusses the theory of the repulsion motor, the methods of operation, and the determination of losses. Diagrams. 2200 w. Elect'n, Lond—Nov. 27, 1908. Serial. 1st part. No. 861 A.

Turbo-Generators.

Tests of Turbo-Generators (Ueber Untersuchungen an Turbogeneratoren). Gives results of efficiency tests of Zoelly, Parsons and Curtis turbo-generators of various sizes. 2000 w. Glückauf—Nov. 21, 1908. No. 1153 D.

ELECTRO-CHEMISTRY.

Cells.

See Standard Cells, under MEASUREMENT.

Electrochemical Equivalents.

The Electrochemical Equivalent of Silver (L'Equivalent électrochimique de l'Argent). P. Janet, F. Laporte and P. de la Gorce. Report from the Laboratoire central d'Electricité. Describes apparatus and methods used in a new determination and gives results. Ills. 3500 w. Bul Soc Int d Elecns—Aug.-Oct., 1908. No. 1103 F.

Electro-Metallurgy.

Heat Conductance Through Walls of Furnaces. Carl Hering. Read before the Am. Elec.-Chem. Soc. On the calculation of the heat conducted from the interior to the outside of an electric furnace through its walls. 4000 w. Elec-Chem & Met Ind—Dec., 1908. No. 760 C.

Electro-Plating.

Warner's Method of Electroplating Flowers. Illustrated detailed description. 2500 w. Brass Wld—Dec., 1908. No. 1323.

Nitric Acid.

The Electric Discharge and the Production of Nitric Acid. William Cramp and Bertram Hoyle. Summarizes methods employed for the fixation of nitrogen, describing an experimental apparatus and the results obtained with it, etc. Ills. 13000 w. Inst of Elec Engrs—Dec., 1908. No. 1389 N.

ELECTRO-PHYSICS.

Alternating Currents.

The Production of Small Variable Frequency Alternating Currents Suitable for Telephonic and Other Measurements. B. S. Cohen. Abstract of a paper read before the Physical Soc. Describes various methods of producing such currents, including a new method. 1200 w. Elect'n, Lond—Dec. 4, 1908. No. 1010 A.

Currents.

Direct and Alternating Currents. S. A. Fletcher. The difference between the two

simply explained. 2200 w. Sci Am Sup—Dec. 26, 1908. No. 1295.

Current Surge.

Current Surge in Closing an Inductive Circuit. J. E. Fries. Discusses the causes and factors of this phenomenon. 2000 w. Elec Age—Nov., 1908. No. 880.

Electrons.

The Discharge of Electricity from Glowing Bodies. Prof. E. Rutherford. Abstract of a lecture before the Manchester Sec. of Inst. of Elec. Engrs. A study of the effect of high temperatures in producing ionization. 1000 w. Elect'n, Lond—Dec. 11, 1908. No. 1211 A.

Induction.

The Induction Law (Des Induktionsgesetz). Fritz Emde. An extensive theoretical discussion. Ills. Serial. 1st part. 3200 w. Elektrotech u Maschinenbau. Nov. 15, 1908. No. 1186 D.

Radiation.

The Luminous Equivalent of Radiation. P. G. Nutting. A discussion of the problem and of the functions involved, aiming to establish a precise relation between light and radiation. 11000 w. Bul Bureau of Stand—Nov., 1908. No. 1348 N.

Selective Radiation from Various Solids. W. W. Coblentz. A qualitative proof of Kirchhoff's law of proportionality between emission and absorption. An examination of the emission spectra of electrical insulators. 7500 w. Bul Bureau of Stand—Nov., 1908. No. 1344 N.

Radio-Activity.

Radio-Active Elements. A. T. Cameron. Information concerning their number and their properties. 3000 w. Sci Am Sup—Dec. 19, 1908. No. 1234.

Resistance.

The Variation of Manganin Resistances with Atmospheric Humidity. F. E. Smith, in the *Phil. Mag.* Describes tests carried out at the Nat. Phys. Laboratory, showing that coils, coated with a varnish which does not absorb moisture, have an advantage over shellac-coated coils. 1700 w. Elect'n, Lond—Nov. 20, 1908. No. 733 A.

Skin Effect.

The Increase in Resistance through the Skin Effect (Ueber die Widerstandszunahme durch Skinwirkung). Dr. F. Rusch. Mathematical. Ills. 2500 w. Elektrotech Zeitschr—Nov. 5, 1908. No. 1199 B.

GENERATING STATIONS.

Accumulators.

The Operation and Maintenance of Storage Batteries. T. P. Strickland. Describes the system in use at the Sydney, N. S. W., Tramway Department. 3000 w. Aust Min Stand—Nov. 18, 1908. Serial. 1st pat. No. 1097 B.

Lead Accumulator Electrolyte. A. Henrick Jackson. Read before the Elec. Assn. of Vic. Considers the nature, density and amount of the electrolyte, its function, purity, etc. 2500 w. Aust Min Stand—Nov. 11, 1908. No. 1088 B.

Accumulators for Peak Loads. A. M. Taylor. Considers the comparative costs and working expenses of steam plant and accumulators, showing the decided advantage of the latter. 2500 w. Elect'n, Lond—Dec. 4, 1908. No. 1009 A.

See also Rotary Converters, under TRANSMISSION.

Central Stations.

The Columbus Municipal Lighting Plant. G. H. Gamper. Illustrated detailed description of this turbine plant. 6500 w. Ohio Soc of Mech, Elec & Steam Engrs, No. 141—Nov., 1908. No. 904 N.

The Power Plant and Transmission System of Castelnuovo-Valdarno, Italy. An illustrated description of a steam power plant installed at lignite mines, generating electrical energy which is transmitted to surrounding cities and towns. 2200 w. Elec Rev, N Y—Dec. 12, 1908. No. 935.

The Electric Power Supply of Marseilles (L'Alimentation de Marseille en Energie électrique). J. Izart. An illustrated description of the Saint-Giniez station. Serial. 1st part. 2800 w. L'Elecn—Nov. 21, 1908. No. 1114 D.

The Electric Plants of the Lauchhammer Company (Die elektrischen Anlagen der Aktiengesellschaft Lauchhammer). Herr Krumbiegel. Illustrated description of an extensive power plant for a manufacturing works. 5500 w. Zeitschr d Ver Deutscher Ing—Nov. 7, 1908. No. 1189 D.

See also Gas Power Plants, under MECHANICAL ENGINEERING, COMBUSTION MOTORS.

Cost Systems.

A System of Cost and Time Keeping in Use at the Columbus, O., Municipal Electric Lighting Plant. G. H. Gamper. Extract from a paper read before the Ohio Soc. of Mech., Elec. & Steam Engrs. 1500 w. Eng News—Dec. 3, 1908. No. 776.

Economics.

Domestic Electricity Supply (Including Heating and Cooking) is Affected by Tariffs. W. R. Cooper. Considers the importance of so adjusting tariffs that electric heating and cooking may be encouraged. 8500 w. Inst of Elec Engrs—Nov. 26, 1908. No. 863 N.

Great Britain.

Some Comparisons of the Electrical Industry in This Country and Abroad. W. M. Mordey. Inaugural address before the Institution of Electrical Engineers on Nov. 19. 5000 w. Engng—Dec. 11, 1908. No. 1218 A.

We supply copies of these articles. See page 904.

Hydro-Electric.

A Low-Head Hydro-Electric Development at Berrien Springs, Michigan. Illustrated description of a development on the St. Joseph River. 4000 w. Eng Rec—Dec. 26, 1908. No. 1248.

Some Problems in Designing the Kern River No. 1 Hydro-Electric Power Plant. F. C. Finkle. An illustrated account of very important problems in hydro-mechanics solved successfully in the design and construction of this power development for the Los Angeles Edison Co. 6500 w. Eng News—Dec. 24, 1908. No. 1236.

The Swedish State Electric Power-Station at Trollhättan. Plan and description of a development on the Göta River, in Sweden. 2500 w. Engng—Dec. 18, 1908. No. 1370 A.

See also Weirs, under CIVIL ENGINEERING, WATER SUPPLY; Water Powers, under CIVIL ENGINEERING, WATERWAYS AND HARBORS; and Turbine Plants, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Isolated Plants.

Natural and Artificial Conservation of Water Power for Electrical Purposes. Edward R. Taylor. Illustrates and describes a number of small plants and power applications on farms, and shows the great amount of power still unused, discussing related questions. 6000 w. Jour Fr Inst—Dec., 1908. No. 968 D.

Parallel Operation.

See A. C. Dynamos, under DYNAMOS AND MOTORS.

Records.

Plans and Records for Electrical Distribution Systems. J. W. Beauchamp. Read before the Leeds Loc. Sec. of the Inst. of Elec. Engrs. General remarks with description of the system developed for Sheffield, England. 2000 w. Elec Engr, Lond—Dec. 18, 1908. Serial. 1st part. No. 1391 A.

Taxation.

Proposal for a Tariff on Electricity and Gas (Entwurf eines Elektrizitäts- und Gassteuergesetzes). Text of a bill before the German Reichstag to establish a tax on electricity and gas undertakings. 20000 w. Elektrotech Zeitschr—Nov. 12, 1908. No. 1302 B

LIGHTING.

Circuits.

See Voltage Regulation, under TRANSMISSION.

Illumination.

The Mechanical Equivalent of Light. J. S. Dow. A résumé of this subject by C. V. Drysdale is reviewed and reference made to other investigators, and to the author's study. Also editorial. 4500 w. Elec Wld—Dec. 12, 1908. No. 927.

Incandescent Lamps.

The Luminous Efficiency of Metal Filament Lamps. W. W. Coblentz. Investigation of the factors producing this efficiency, especially the so-called radiation constant a. 1200 w. Elec Wld—Dec. 19, 1908. No. 1271.

New Incandescent Lamps. Francis E. Cady. Discusses the new metallic filament lamps, their manufacture, physical and electrical properties, etc. 3000 w. Cent Sta—Dec., 1908. No. 934.

Photometry.

The Determination of the Mean Spherical Intensity of a Source of Light. E. W. Weinbeer. Describes a slide-rule for its direct determination. 600 w. Elec Wld—Dec. 26, 1908. No. 1286.

POWER APPLICATIONS.

Agriculture.

Applications of Electricity in Agriculture (Aplicaciones de la Electricidad á la Agricultura). D. Hermenegildo Gorria. A general review. Serial. 1st part. 4000 w. Energia Elec—Nov. 10, 1908. No. 1139 D.

See also Isolated Plants, under GENERATING STATIONS.

Brakes.

See same title, under MECHANICAL ENGINEERING, MACHINE ELEMENTS AND DESIGN.

Heating.

Commercial Electric Heating. John Roberts. Considers a change in methods of distribution necessary and gives suggestions. 3500 w. Inst of Elec Engrs—Nov. 26, 1908. No. 864 N.

See also Economics, under GENERATING STATIONS.

Machine Tools.

See Electric Driving, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

Marseilles Congress.

The International Congress on the Applications of Electricity (Le Congrès international des Applications de l'Electricité). Paul Janet. A general outline of the proceedings. 7200 w. Rev Gen d Sci—Nov. 30, 1908. No. 1113 D.

Mining.

See Electric Power, under MINING AND METALLURGY. COAL AND COKE, and under MINING.

Refrigerating Machines.

See Refrigeration, under MECHANICAL ENGINEERING, HEATING AND COOLING.

Welding.

See same title, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES.

We supply copies of these articles. See page 904.

MEASUREMENT.

Dynamo Testing.

The Testing of Alternators. Stanley P. Smith. Abstract of paper before the Birmingham Sec. of the Inst. of Elec. Engrs. Discusses methods and their defects. 3500 w. Elec Engr, Lond—Nov. 27, 1908. No. 859 A.

The Practical Testing of Dynamos and Motors. H. E. Mellor. Read before the Owens College Engng. Soc. States principles, describing tests for short circuits, bad connections, etc., in armatures for d. c. machines; stators for induction motors, alternators, synchronous motors; rotors for induction motors; magnet coils for d. c. machines and alternators. 4500 w. Mech Engr—Nov. 27, 1908. No. 856 A.

Electrodynamometers.

A New Absolute Electrodynamometer and the Determination of the Electromotive Force of a Weston Cell (Nouvel Electrodynamomètre absolu et Détermination de la Force électromotrice de l'Elément du Type Weston). H. Pellat. Report from the Laboratoire central d'Electricité. Ills. 21000 w. Bul Soc Int d Elecns—Aug.-Oct., 1908. No. 1106 F.

Determination of the Constant of an Absolute Electrodynamometer by an Induction Phenomenon (Détermination de la Constante d'un Electrodynamomètre absolu par un Phénomène d'Induction). A. Guillet. Report from the Laboratoire central d'Electricité. Describes the Lippmann method, the apparatus and calculations involved and the application of the results to the determination of the electromotive force of a cadmium cell. Ills. 9000 w. Bul Soc Int d Elecns—Aug.-Oct., 1908 No. 1104 F.

See also Standard Cells, under MEASUREMENT.

Frequency.

Stroboscopic Measurements of Alternating-Current Frequency with Electric Lamps. A. E. Kennelly. An account of measurements to about one-tenth of 1 per cent, with no other apparatus than a permanent magnet and an incandescent lamp, with the aid of a stroboscopic fork. 1500 w. Elec Wld—Dec. 26, 1908. No. 1284.

Laboratories.

The New Laboratory of the Electrical Engineering Department at the Ohio State University. F. C. Caldwell. Illustrated detailed description of the building and its equipment. 3000 w. Ohio Soc of Mech, Elec, & Steam Engrs, No. 146—Nov., 1908. No. 908 N.

Magnetic Testing.

Errors in Magnetic Testing with Ring Specimens. M. G. Lloyd. Discusses the inaccuracy of the apparent values of mean gilberts per centimeter, and of the mean hysteretic power obtained from ring test pieces, owing to the differences of perimeter at the inside and outside of the ring. Gives a correction factor. 1500 w. Elec Wld—Dec. 26, 1908. No. 1285.

Meters.

The Measurement of Energy in Single-Phase Three-Wire Systems (Energiemessung in Wechselstrom-Dreileiteranlagen durch Elektrizitätsmesser). Rudolf Kopp. Shows the use of the induction meter for this purpose. Mathematical. Ills. 3700 w. Elektrotech Zeitschr—Nov. 12, 1908. No. 1301 B.

Meter Testing.

The Use of a Phase-Shifting Transformer for Wattmeter and Supply Meter Testing. C. V. Drysdale. An illustrated description of the instrument and its use. 1500 w. Elect'n, Lond—Dec. 11, 1908. No. 1210 A.

Motor Testing.

See Dynamo Testing, under MEASUREMENT.

Oscillographs.

The Oscillograph. A. H. Forman. Brief discussion of examples of three general types. 2000 w. Sib Jour of Engng—Nov., 1908. No. 835 C.

Photometry.

See same title, under LIGHTING.

Standard Cells.

The Standard Cadmium Cell (L'Elément étalon au Cadmium). P. Janet and R. Jouaust. Report from the Laboratoire central d'Electricité. A general discussion and results of researches. Ills. 16000 w. Bul Soc Int d Elecns—Aug.-Oct., 1908. No. 1101 F.

The Temperature Formula of the Weston Standard Cell. F. A. Wolff. Describes investigations made, discussing results and stating conclusions. 7500 w. Bul Bureau of Stand—Nov., 1908. No. 1349 N.

Determination by an Absolute Electrodynamometer of the Electromotive Force of Cadmium Cells (Détermination par un Electrodynamomètre absolu de la Force électromotrice des Eléments au Cadmium). P. Janet, F. Laporte and R. Jouaust. Report from the Laboratoire central d'Electricité. Describes the instrument and methods of tests and gives results. Ills. 18000 w. Bul Soc Int d'Elecns—Aug.-Oct., 1908. No. 1102 F.

See also Electrodynamometers, under MEASUREMENT.

Standards.

The Construction of Standards of the International Ohm (Note sur la Construction d'Etalons de l'Ohm international). J.-René Benoit. Report from the Laboratoire central d'Electricité. Describes the method. 3300 w. Bul Soc Int d'Elecns—Aug.-Oct., 1908. No. 1105 F.

We supply copies of these articles. See page 904.

Units.

The Principles Involved in the Selection and Definition of the Fundamental Electrical Units to Be Proposed for International Adoption. F. A. Wolff. 6500 w. Bul Bureau of Stand—Nov., 1908. No. 1347 N.

TRANSMISSION.

Cables.

Cost of High-Tension Underground Cables. Henry Floy. Discusses methods of estimating cost. 1500 w. Elec Wld—Dec. 12, 1908. No. 929.

The Short-Period Carrying Capacity of Cables. William A. Del Mar. Develops a corresponding formula and table for cables in such a manner as to determine their over-load time-current curves. Describes investigations. Also editorial. 2000 w. Elec Wld—Dec. 12, 1908. No. 926.

Conduits.

Underground Construction. H. B. Gear and P. F. Williams. A review of the various systems developed. illustrating and describing present practice. 4500 w. Elec Age—Nov., 1908. No. 881.

High Tension.

Some Features of European High-Tension Practice. Frank Koester. Illustrates and describes especially the features uncommon in American practice. 3300 w. Elec Age—Dec., 1908. No. 1227.

Insulators.

Flash-Over Voltages. J. Lustgarten. The effects of high-voltages on the air, the nature and properties of the gaseous ion, explaining the mechanism of the brush, spark and arc discharges, etc. 5000 w. Elect'n, Lond—Dec. 18, 1908. No. 1393 A.

Lightning.

New Discoveries About Lightning. James Cooke Mills. A report of the experiments made by Alex Larsen, with comments. 2000 w. Sci Am—Dec. 12, 1908. No. 930.

Lightning Arresters.

Recent Progress in the Study of Atmospheric Discharges and of Lightning Arresters (Progrès Récents réalisés dans l'Etude des Décharges atmosphériques et des Parafoudres). A. R. Garnier. Ills. 2000 w. L'Elecn—Nov. 21, 1908. No. 1115 D.

The Testing of Lightning Arresters (Sulla Prove dei Parafulmini). Illustrated description of an electrical method. 3200 w. Elettricita—Nov. 19, 1908. No. 1130 D.

Line Design.

Errors in Some Methods of Calculating Alternating-Current Transmission Lines. L. W. Rosenthal. Points out the practical conditions under which these solutions may lead to undesirable errors. 700 w. Elec Wld--Dec. 19, 1908. No. 1270.

Permutator.

The Permutator. A description of this current-changing device, with editorial comment. 6000 w. Elec Age—Nov., 1908. No. 879.

Poles.

The Strength of Wood Poles (Sulla Rottura dei Pali di Legno nelle Linee elettriche). Salvatore Spera. Mathematical discussion of the stresses in transmission line poles. Ills. 2500 w. Industria—Nov. 15, 1908. No. 1132 D.

Rotary Converters.

Discussion on "Voltage Ratio in Synchronous Converters, with Special Reference to the Split Pole Converter," and on "Applications of Storage Batteries to Regulation of Alternating-Current Systems." Atlantic City, N. J., July 1, 1908. Papers by Comfort A. Adams, and by J. L. Woodbridge are discussed. 10800 w. Pro Am Inst of Elec Engrs—Jan., 1909. No. 1364 F.

Transformers.

Transformers: Some Theoretical and Practical Considerations. A. P. M. Fleming and K. M. Faye Hansen. Abstract of a paper read before the Manchester Local Sec. of the Inst. of Elec. Engrs. Gives in full the remarks on the practical side. Ills. 4000 w. Elec Engr, Lond—Dec. 4, 1908. No. 1006 A.

Three-Phase—Two-Phase Transmission by Standard Transformers. L. A. Starrett. Presents methods of transforming which have proved satisfactory. 1000 w. Elec Jour—Dec., 1908. No. 978.

Transformer Connections. Considers some of the most common problems. 1500 w. Prac Engr—Dec. 11, 1908. Serial. 1st part. No. 1200 A.

The Parallel Connection of Three-Phase Transformers. A method to aid in correct inter-connection, given by K. Faye-Hansen, in the E. T. Z. 800 w. Elec Rev, Lond—Dec. 11, 1908. No. 1208 A.

Star and Delta Transformer Interconnections. W. T. Ryan. Discusses the various types of interconnection, considering disturbances that may arise in a three-phase system. 600 w. Elec Wld—Dec. 5, 1908. No. 809.

Troubles.

Lessons from Some Recent Electrical Troubles. Cites a number of accidents due to improper operation. 1700 w. Elec Wld—Dec. 5, 1908. No. 810.

Underground.

Discussion on "High-Potential Underground Transmission." New York, Oct. 9, 1908. Discussion of paper by P. Junkersfeld and E. O. Schweitzer. 10500 w. Pro Am Inst of Elec Engrs—Jan., 1900. No. 1366 F.

We supply copies of these articles. See page 904.

Underground Cable and Service Distribution, Edison System. Ralph W. Krass. Deals with the underground installations of the various systems, and describes the method of connection with overhead feeders for outlying districts. 2500 w. Sib Jour of Engng—Dec., 1908. No. 1352 C.

Voltage Regulation.

Conditions Affecting Stability in Electric Lighting Circuits. Elihu Thomson. Discusses mainly the constant-current series circuits containing arc lamps, reviewing the methods tried during the last 30 years to obtain stability. 7500 w. Pro Am Inst of Elec Engrs—Jan., 1909. No. 1362 F.

Protection and Safety from Excess Voltages (Gesichtspunkte hinsichtlich Schutz und Sicherheit gegen Ueberspannungen). Karl Kuhlmann. Mathematical discussion of the possible causes of excess voltages. Ills. Serial. 1st part. 2800 w. Elektrotech Zeitschr—Nov. 12, 1908. No. 1300 B.

Excess-Voltage Protective Devices of the Société Générale des Condensateurs Electriques, Freiburg (Ueberspannungssicherungen nach dem System der Société Générale des Condensateurs Electriques, Freiburg). Illustrated description and report of tests. Serial. 1st part. 2400 w. Elektrotech u Maschinenbau—Nov. 22, 1908. No 1187 D.

MISCELLANY.

Aluminium.

See same title, under MINING AND METALLURGY, MINOR MINERALS.

Problems.

The Technical and Social Problems of the Distribution of Electrical Energy (Il Problema tecnico e sociale della Distribuzione di Energia elettrica). C. Coltri. Refers particularly to conditions in Italy. Serial, 1st part. 3000 w. Industria—Nov. 29, 1908. No. 1135 D.

INDUSTRIAL ECONOMY

Accounting.

Electric Manufacturing Companies' Accounts. Discusses matters in connection with the affairs of such companies, outlining a system. 2000 w. Elec Rev, Lond—Dec. 18, 1908. No. 1392 A.

Co-partnership.

Co-partnership and Unemployment. Sir Benjamin C. Browne. Reviews some of the schemes that have been tried. 3000 w. Engr, Lond—Dec. 4, 1908. No. 1021 A.

Cost Systems.

Systematic Foundry Operation and Foundry Costing. C. E. Knoeppel. This fourth article of a series discusses the apportionment of various elements to production. 4000 w. Engineering Magazine—Jan., 1909. No. 1329 B.

See also same title, under ELECTRICAL ENGINEERING, GENERATING STATIONS; and Time Keeping, under INDUSTRIAL ECONOMY.

Education.

Discussion on "A New Method of Training Engineers," and "The Relation of the Manufacturing Company to the Technical Graduate," Atlantic City, N. J., July 2, 1908. Papers by Magnus W. Alexander, and by David B. Rushmore are discussed. 7000 w. Pro Am Inst of Elec Engrs—Jan., 1909. No. 1363 F

The Commercial Training of the Engineer (L'Instruction commerciale de l'Ingénieur). Maurice Bellom. Discusses the need for training engineers in economic principles, languages, etc. 3000 w. Génie Civil—Nov. 21, 1908. No. 1124 D.

See also same title, under MARINE AND NAVAL ENGINEERING.

Engineering Opportunities.

Some Opportunities on the Shop Side in the Engineering Industries. C. B. Auel. Discusses the specialization of modern manufacturing establishments. 3000 w. Elec Jour—Dec., 1908. No. 977.

Inland Navigation.

Utility of Waterways as a Factor in Transportation. J. A. Ockerson. An address before the River and Harbor Convention. 4000 w. Eng Rec—Dec. 19, 1908. No. 1055.

Inventions.

Salient Points for Inventors—Making and Preserving Records. John D. Morgan. Suggestions for recording evidence of first invention. 2000 w. Am Mach—Vol. 31. No. 52. No. 1278.

Management.

Efficiency as a Basis for Operation and Wages. Harrington Emerson. The location and elimination of wastes is discussed in this seventh article of a series. 3000 w. Engineering Magazine—Jan., 1909. No. 1333 B.

See also Time Keeping, under INDUSTRIAL ECONOMY; and Management, under RAILWAY ENGINEERING, MISCELLANY.

We supply copies of these articles. See page 904.

Marine Transport.

Comprehensive Report on Waterway and Maritime Conditions Throughout the World—Strong Plea for American Ships. C. M. Chester. Special report to National Rivers and Harbor Congress. 3000 w. Naut Gaz—Dec. 24, 1908. No. 1259.

Natural Resources.

The Need for Conserving the Mineral Wealth of the United States. Report submitted by the Minerals Section of the National Conservation Commission to the Conference on Dec. 9. 2000 w. Eng News—Dec. 17, 1908. No. 985.

Patents.

Our Antiquated Patent System. Ludwig Gutmann. A critical discussion of features of the patent laws of the United States. 2000 w. Elec Wld—Dec. 26, 1908. No. 1288.

Purchasing.

The Purchase of Pattern Lumber. Oscar E. Perrigo. Suggestions for effecting economies in the purchase and care of raw material for the pattern shop. Ills. 5000 w. Foundry—Dec., 1908. No. 758.

Tariff.

Tariff Hearings at Washington. A summary of the statements on the metal schedule. 33000 w. Ir Age—Nov. 26, 1908. Serial. 1st part. No. 788.

Time Keeping.

Something New in Machine-Shop Time-Keeping. Illustrates and describes a system where the data are telephoned to the office and recorded by aid of the calculagraph, without the workman leaving his machine. 1200 w. Am Mach—Vol. 31. No. 52. No. 1276.

See also Cost Systems, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

MARINE AND NAVAL ENGINEERING

Ammunition.

The Progressive Decomposition of Gun-Cotton During Its Storage. M. M. O. Silberrad and R. C. Farmer. Gives results of researches on the decomposition of gun-cotton. 2500 w. Jour Fr Inst—Dec., 1908. No. 971 D.

British Navy.

The Two Power Standard for the Navy. Sir William H. White. An examination of the reasons advanced for the new shipbuilding programme in England, explaining the present naval situation. 8500 w. Nineteenth Century—Dec., 1908. No. 1267 D.

Compass Deviation.

Change in Deviation of the Compass Due to Change in Trim. Lloyd H. Chandler. An investigation of the effect of an abnormal trim. Mathematical. 2000 w. Pro U S Naval Inst—Dec., 1908. No. 1336 F.

Education.

Naval Engineering Education in Great Britain. Sir William H. White. Address before the Royal Society of Arts. An account of the methods adopted for the education of naval architects in Great Britain during the past century. 10000 w. Jour Soc of Arts—Nov. 20, 1908. No. 725 A.

Electric Power.

The Lighting and Power Arrangements and Other Uses of Electricity in a Modern Steamship. Louis P. Zimmerman. Illustrated description of the equipment of the "Minnesota," a combined passenger and freight-carrying vessel, 630 feet in length. 2500 w. Elec Rev, N Y—Dec. 19, 1908. No. 1061.

Floating Cranes.

Description of a 140-Ton Floating Crane with a Test Capacity for Lifting 200 Tons. H. Prime Keffer. Illustrates and describes a new and interesting type built at Duisburg, Germany. 1400 w. Int Marine Engng—Dec., 1908. No. 750 C.

Gas Engines.

Gas vs. Steam for Marine Motive Power. A. B. Willits. Discusses the present standing of the suction-gas producer and gas engine, showing that until changes are made, it will be unavailable for high-power marine work. 12000 w. Pro U S Naval Inst—Dec., 1908. No. 1334 F.

Motor Boats.

See Ignition, under MECHANICAL ENGINEERING, AUTOMOBILES.

Shipbuilding.

Messrs. Yarrow's New Works on the Clyde. Illustrated detailed description of the Scotstoun works, Glasgow, and their equipment. 7500 w. Engng—Dec. 11, 1908. No. 1213 A.

The Determination of the Dimensions of Building Slips (Die Bestimmung der Hellingabmessungen für den Fall kostspieliger Hellinganlagen). Albert Lincke. Gives tables of averages showing the most satisfactory and useful proportions. Ills. Serial, 1st part. 4000 w. Schiffbau—Nov. 11, 1908. No. 1164 D.

See also Cableways, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

We supply copies of these articles. See page 904.

Ship Design.

Fast Steamers Built on "Tetrahedral" Lines. Otto Kretschnaer. Discusses the advantages of such a model. 900 w. Sci Am—Dec. 26, 1908. No. 1294.

Ship Repairing.

Facilities for Repairing Ships in Italian Harbors (I Mezzi di Raddobbo per Navi esistenti nei Porti Italiani). Luigi Luiggi. Illustrates and describes the docking facilities of the more important harbors. 3000 w. Ann d Soc d Ing e d Arch Ital—Nov. 1, 1908. No. 1129 F.

Ship Rolling.

The Dynamics of Rolling of a Ship. Sir G. Greenhill. An explanation of the mathematical theory of the motion of a ship, with remarks on the effect of design, storage of coal and cargo, etc. 2000 w. Engr, Lond—Dec. 11, 1908. No. 1219 A.

Ship Sanitation.

The Sanitation of Modern Passenger Ships. F. M. Williams. Discusses the Peninsular and Oriental Co., trading to the east, and the Cunard vessels in the Atlantic service and the successful arrangements. Also discussion. 3500 w. Jour Roy San Inst—Dec., 1908. Serial, 1st part. No. 999 A.

Steam Engineering.

Steamship Engineering Economies. Discusses possible economies in marine practice. 2000 w. Int Marine Engng—Dec., 1908. No. 751 C.

Steam Engines.

The Reciprocating Marine Engine. Abstract of a paper by D. Gibson, before the Manchester Assn. of Engrs. Discusses its present and future standing. 1800 w. Engr, Lond—Dec. 18, 1908. No. 1375 A.

The Propelling Engines of H. M. Cruiser "Defence." Plate and description. 1000 w. Engng—Dec. 18, 1908. No. 1374 A.

James P. Allaire and the Allaire Works. Edward P. Buffet. Gives facts concerning an early steam engine industry and its founder. 2500 w. Power—Dec. 8, 1908. No. 878.

Steamships.

The White Star Liner Megantic. Illustrated description. 600 w. Engr, Lond—Dec. 18, 1908. No. 1378 A.

A Modern Floating Hotel. Julius Grundmann. Illustrated description of the North German Lloyd liner "Kronprincessin Cecilie." 2500 w. Cassier's Mag—Dec., 1908. No. 948 B.

The Mallory Line Steamship Brazos. Sidney Graves Koon. Illustrated detailed description of this new steel twin-screw steamer. 3500 w. Int Marine Engng—Dec., 1908. No. 749 C.

Some Features of the Propelling Machinery and Result of Performance of the New Mallory Line Steamship Brazos. 3000 w. Naut Gaz—Dec. 10, 1908. No. 914.

The Steamship "George Washington." Illustrated description of the latest type of passenger and freight-carrying steamship. 1000 w. Sci Am Sup—Dec. 19, 1908. No. 1232.

Submarine Signalling.

Protection Against Fog Dangers at Sea. J. Erskine Murray. An illustrated account of the development of submarine signalling. 4500 w. Cassier's Mag—Dec., 1908. No. 946 B.

Torsion Meters.

See same title, under MECHANICAL ENGINEERING, MEASUREMENT.

United States Navy.

A Short Account of Legislative Action in Regard to the United States Navy Up to the War of 1812, and Notes Concerning the Histories of Naval Vessels During That Period. A. Farenholt. 7000 w. Pro U S Naval Inst—Dec., 1908. No. 1337 F.

Reuterdahl's Criticism of the Ships of the American Navy (Le Critiche di Reuterdahl alle Navi della Marina Americana). L. Barberis. A general discussion. Ills. 7500 w. Riv Marit—Nov., 1908. No. 1128 E + F.

MECHANICAL ENGINEERING

AUTOMOBILES.

Bugatti.

The Bugatti Automobile (Automobiles Bugatti). A. Heller. Illustrated description of this car built by the Gasmotorenfabrik at Deutz. 2000 w. Génie Civil—Nov. 7, 1908. No. 1122 D.

Commercial Vehicles.

Twelve Years' Progress in Commercial Vehicles. E. Shrapnell Smith. Read before the Royal Auto. Club, London. A review of progress, cost, performance, etc. 3500 w. Automobile—Dec. 17, 1908. No. 1029.

The Evolution of the Industrial Vehicle (L'Evolution du Véhicle industriel). M. G. Lumet. Report of the 1908 commercial-vehicle competition of the Automobile Club of France. Ills. 7000 w. Mem Soc of Ing Civ de France—Oct., 1908. No. 1303 G.

Automobile Fire Apparatus (Feuerwehr-automobile). Illustrated description of German models of hose wagons, ladder trucks, etc. 3500 w. Zeitschr d Mit Motorwagen-Ver—Nov. 15, 1908. No. 1175 D.

Motor Ambulances (Automobil-Krankenwagen). Illustrated description of German models. 2200 w. Zeitschr d Mit Motorwagen-Ver—Nov. 15, 1908. No. 1173 D.

See also Street Cleaning, under CIVIL ENGINEERING, MUNICIPAL.

Corbin.

New Corbin Makes Its Bow for 1909. Charles B. Hayward. Illustrated description of new features. 1500 w. Automobile—Dec. 10, 1908. No. 916.

Crank Shafts.

See same title, under MACHINE ELEMENTS AND DESIGN.

Driving.

Some Pertinent Hints for the American Autoist. Calls attention to important points to be considered by autoists. 2500 w. Automobile—Dec. 10, 1908. No. 917.

Exhibitions.

Lessons from the Motor-Car Show at Olympia. A general review of the progress shown. 3500 w. Engng—Dec. 4, 1908. No. 1019 A.

Motor-Car Exhibition at Olympia. Illustrates and describes interesting exhibits of pleasure cars and accessories. 1500 w. Engr, Lond—Nov. 20, 1908. Serial. 1st part. No. 743 A.

Explosions.

The Danger of Explosion in Automobiles (Zur Frage der Explosionsgefahr bei Automobilen). Herr Effenberger. Discusses the explosions to which the automobile is liable and means of lessening the dangers, giving results of tests. Ills. 5500 w. Zeitschr d Mit Motorwagen-Ver—Nov. 15, 1908. No. 1174 D.

Fuels.

See Coking By-Products, under MINING AND METALLURGY, COAL AND COKE.

Garages.

The Heating of Motor Houses. Illustrates and describes various devices. 1800 w. Autocar—Dec. 5, 1908. No. 1003 A.

Gears.

Toughened Gears for Automobiles. J. M. Howe. Describes process of hardening and tempering used in Europe with "Mangano Siliceux" steel. 1000 w. Am Mach—Vol. 31. No. 51. No. 1075.

Gregoire.

The 14-H.P. Gregoire Petrol Car. Illustrated description of a low-priced French car. 1000 w. Auto Jour—Dec. 19, 1908. No. 1384 A.

Headlights.

The Bleriot "No Glare" Headlight. Illustrated description of a "No-glare" automobile lamp. 700 w. Auto Jour—Dec. 19, 1908. No. 1383 A.

Ignition.

The Bosch Magnetic Igniter. Illustrated description of this system. 1500 w. Auto Jour—Dec. 12, 1908. No. 1098 A.

Getting Acquainted with Make and Break Ignition. Herbert L. Towle. An illustrated explanation of the make and break system. 2500 w. Rudder—Dec., 1908. No. 900 C.

Lanchester.

The New Wheel-Steering Lanchester Car at Olympia. Illustrates and describes a 6-cylinder vehicle equipped with wheel steering and gate control. 1700 w. Auto Jour—Nov. 28, 1908. No. 849 A.

Motors.

Comparing Long and Short Stroke Motors. E. A. Myers. Showing the desirability of the long stroke. 1800 w. Automobile—Dec. 24, 1908. No. 1266.

Combustion Motors of Large Power Per Unit of Weight (Les Moteurs à Mélange tonnant à grande Puissance massique). M. G. Lumet. Discusses the factors which influence the relation between weight and power and gives the results of some tests carried out by the Automobile Club of France. Ills. 6000 w. Mem Soc Ing Civ de France—Oct., 1908. No. 1304 G.

N. A. G.

The 12-14-H.P. N.A.G. Car. Illustrated description of a German Chassis. 1200 w. Auto Jour—Dec. 5, 1908. No. 1005 A.

Pierce.

Pierce Arrows for 1909. Illustrates and describes the new features introduced and new types. 3000 w. Automobile—Dec. 17, 1908. No. 1031.

Pullman.

Pullman in Several 1909 Models. Brief illustrated descriptions. 1600 w. Automobile—Dec. 24, 1908. No. 1264.

Regal.

Regal in 1909 Form. Charles B. Hayward. Illustrates and describes new features. 1200 w. Automobile—Dec. 24, 1908. No. 1265.

Testing.

The Use of Electricity in Testing Automobiles. Dr. Alfred Gradenwitz. Illustrated description of the dynamometer plant used by the Am. Auto. Club. 1500 w. Elec Rev, Lond—Dec. 11, 1908. No. 1207 A.

Tires.

The Alley Tyre Manipulator. Illustrated description of a device for facilitating the dismounting and fitting of tyres. 1000 w. Autocar—Dec. 5, 1908. No. 1004 A.

About the Auto's Indispensable Footwear. Suggestions from a book by C. A.

We supply copies of these articles. See page 904.

Shaler relating to care, repairs, etc. 2500 w. Automobile—Dec. 17, 1908. No. 1030.

Transmissions.

Manly Hydraulic Variable Speed Transmission. Thomas J. Fay. Illustrates and describes this system. 1000 w. Automobile—Dec. 10, 1908. No. 915.

COMBUSTION MOTORS.

Gas Analysis.

Moisture in Producer Gas. J. MacFarlane. Explains methods used by the writer for the determination of moisture. Plate. 1500 w. Jour W of Scotland Ir & Steel Inst—Oct., 1908. No. 895 N.

Gas-Engine Governing.

Governing Gas Engines. L. B. Lent. Discusses the proper action of the governor and related matters. 1500 w. Power—Dec. 22, 1908. No. 1079.

Gas Engines.

Reminiscences of a Gas Engine Designer. L. H. Nash. Describes some ideas that have been tried, and principles of engine construction. Ills. 4000 w. Jour Am Soc of Mech Engrs—Dec., 1908. No. 840 F.

The Waste Heat of the Gas Engine. Cecil P. Poole. Gives a brief analysis of methods of utilizing waste heat, showing the fallacy of assuming that all the waste heat is available. 1600 w. Power—Dec. 8, 1908. No. 876.

A New Gas-Engine Cycle. Robert Miller. Describes the cycle devised by the writer, explaining its advantages, and illustrating the Miller single-crank, double-acting gas engine. 2500 w. Int Marine Engng—Dec., 1908. No. 752 C.

The Griffin Enclosed Gas-Engine. Illustrated description of a two-cylinder three-cycle engine. 800 w. Engng—Dec. 4, 1908. No. 1018 A.

The Influence of Large Gas Engines on Steel-Works Development (Einfluss der Grossgasmaschine auf die Entwicklung der Hüttenwerke). A. Bonte. A general review of the use of gas power in steel works with special reference to Germany. 5000 w. Zeitschr d Ver Deutscher Ing—Nov. 28, 1908. No. 1197 D.

See also Refrigeration, under HEATING AND COOLING; and Gas Engines, under MARINE AND NAVAL ENGINEERING.

Gas-Engine Testing.

Testing Gas Engines and Motors. E. S. Frash. On the prony brake and indicator tests in internal combustion work. 1200 w. Power—Dec. 29, 1908. No. 1317.

See also Testing Laboratories, under MEASUREMENT.

Gas Power Plants.

The Reliability of the Producer Gas Plant. Godfrey M. S. Tait. A discussion of recent reliability tests. 900 w. Cassier's Mag—Dec., 1908. No. 953 B.

A Clean Cut Factory Gas Power Plant. Cecil P. Poole. Illustrated description of a 60-cycle plant operating in parallel, at Swissvale, Penn. 2000 w. Power—Dec. 8, 1908. No. 873.

A Notable Producer Gas Power Station. Cecil P. Poole. Illustrated description of a railway and lighting plant at Charlotte, N. C., in which 60-cycle alternators are driven in parallel by gas engines supplied by bituminous producers. 1500 w. Power—Dec. 22, 1908. No. 1077.

The New Gas Power Plant of the Union Switch & Signal Company. Illustrated detailed description of the plant at Swissvale, near Pittsburg, Pa. 2000 w. Eng Rec—Dec. 12, 1908. No. 958.

See also Rolling Mills, under MINING AND METALLURGY, IRON AND STEEL.

Gas Producers.

Vital Points in Producer Construction. F. C. Tryon. Criticism and suggestions. 3000 w. Power—Dec. 1, 1908. No. 722.

Ignition.

The Lodge "B" Spark High-Tension Ignition. Describes a new type brought out by Sir Oliver Lodge. Ills. 1000 w. Sci Am Sup—Dec. 5, 1908. No. 819.

Oil Engines.

Oil Engines. W. A. Tookey. Abstract of a paper read before the Manchester Assn. of Engrs. Considers the differences in the methods of treatment adopted by makers, and the salient features. Ills. 3000 w. Mech Engr—Nov. 20, 1908. No. 730 A.

Tests of a Diesel Motor (Versuche an einem Dieselmotor). Dr. Karl Kobes. An elaborate mathematical discussion of a number of tests of a 70 horse-power oil motor belted to a dynamo. Ills. Serial. 1st part. 3500 w. Zeitschr d Oest Ing u Arch Ver—Nov. 20, 1908. No. 1180 D.

HEATING AND COOLING.

Electric Heating.

See Heating, under ELECTRICAL ENGINEERING, POWER APPLICATIONS.

Heat Losses.

Evolution in Heating. J. M. W. Kitchen. Introductory to a series of articles illustrating the theories on which the writer bases his arguments in regard to heat losses. Ills. 2000 w. Heat & Vent Mag—Nov., 1908. Serial. 1st part. No. 903.

The Effect of Wind on Heating and Ventilation. H. W. Whitten. A study of heat losses and means of lessening them, window construction and related matters. General discussion. Ills. 6000 w. Pro Engrs' Soc of W Penn—Nov., 1908. No. 779 D.

Hot-Air Heating.

Theoretical Considerations in the Design of Residence Furnace Heating Systems. James D. Hoffman. Mentions the advantages and disadvantages of such a

system, and considers points to be calculated in the design. 2500 w. Met Work—Dec. 26, 1908. No. 1258.

Recent Investigations in Hot-Air Heating and Ventilating (Sopra recenti Studi di Ventilazione e Riscaldamento ad Aria calda). Luigi Boldrocchi. Illustrates and describes recent systems and appliances. Serial. 1st part. 1800 w. Industria—Nov. 15, 1908. No. 1133 D.

See also Ventilation, under HEATING AND COOLING.

Refrigeration.

Reinforced Concrete Freezing Tanks. William M. Torrance. Read before the Am. Soc. of Refrig. Engrs. Describes the construction and gives the author's experience. Ills. 1500 w. Cold Storage & Ice—Dec., 1908. No. 990 C.

Waterproofing in Refrigerating Work. Edward W. De Knight. Read before the Am. Soc. of Refrig. Engrs. Discusses the rigid method of treatment and the elastic or membrane method. 5500 w. Cold Storage & Ice—Dec., 1908. No. 988 C.

The Refrigerating Machine and the Gas Engine. Joseph H. Hart. Analogy between the ammonia absorption machine and the internal combustion motor. 2500 w. Cassier's Mag—Dec., 1908. No. 949 B.

Single and Double-Acting Ammonia Compressors. Thomas Baker. Brief discussion of the comparative advantages. 900 w. Ohio Soc of Mech, Elec, & Steam Engrs, No. 143—Nov., 1908. No. 906 N.

Performance of Ammonia Compression Machines. Charles Edward Lucke. Read before the Am. Soc. of Refrig. Engrs. An illustrated article reporting tests, giving results, and describing methods. Also reply by Thomas Shipley. 16800 w. Cold Storage & Ice—Dec., 1908. No. 991 C.

Standard Method of Testing Refrigerating Machines. D. S. Jacobus. Read before the Am. Soc. of Refrig. Engrs. Reviews the work in this field by the A.S.M.E. and states points that should be considered. 2000 w. Cold Storage & Ice—Dec., 1908. No. 989 C.

Electricity in Refrigeration. R. Louis Lloyd. Describes electrical refrigerating machines in operation in Philadelphia, giving costs. Ills. 4000 w. Jour Fr Inst—Dec., 1908. No. 970 D.

Ethyl Chloride Refrigeration. C. C. Palmer. Read before the Am. Soc. of Refrig. Engrs. Gives results of experiences with ethyl chloride as a refrigerating agent. 2000 w. Cold Storage & Ice—Dec., 1908. No. 987 C.

See also Dry-Air Blast, under MINING AND METALLURGY, IRON AND STEEL; and Refrigeration, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Steam Heating.

Installing Heating Systems in Close Quarters. Illustrates and describes the installations at the Importers' and Traders' National Bank, and at the New York Law School, in New York City. 2000 w. Heat & Vent Mag—Dec., 1908. No. 1325.

Textile Mills.

Heating, Cooling, Moistening and Renewing the Air of Textile Mills (Die Erwärmung, Kühlung, Befeuchtung und Erneuerung der Raumluft in der Textilindustrie). E. Stadelmann. A practical discussion of methods. Ills. 5500 w. Gesundheits-Ing—Nov. 14, 1908. No. 1171 D.

Ventilation.

Single Fan vs. Double Fan Systems of Heating and Ventilation. H. L. Williams. Discusses and compares the efficiency of these two systems. 2500 w. Heat & Vent Mag—Nov., 1908. No. 901.

Fan and Heater Arrangements. Charles L. Hubbard. Shows different methods of placing the important parts of a ventilating plant to meet various conditions. Ills. 1000 w. Heat & Vent Mag—Nov., 1908. No. 902.

See also Heat Losses, under HEATING AND COOLING; and Mechanical Plants, under POWER AND TRANSMISSION.

HYDRAULIC MACHINERY.

Centrifugal Pumps.

Kinematics of One Form of Rotary Pump or Blower. Samuel W. Balch. Presents some elements in the design of one of the earliest forms of rotary pump or blower. 1500 w. Sch of Mines Qr—Nov., 1908. No. 972 D.

Balancing the Thrust in Centrifugal Pumps. L. Roedel. Explains the cause of "axial pressure," and how it affects devices designed to equalize this thrust. 2000 w. Power—Dec. 8, 1908. No. 874.

Pressure Regulators.

See Turbine Pressures, under HYDRAULIC MACHINERY.

Pumping Engines.

Slip of Pumping Engines. The importance of considering it in waterworks calculations is shown, results of tests given, and methods for measuring it described. 2000 w. Munic Jour & Engr—Dec. 16, 1908. No. 1040.

Triple-Expansion Engines and Pumps for Burma Oil Pipe-Line. Illustrated description. 600 w. Engng—Dec. 18, 1908. No. 1372 A.

Pumping Plants.

The Repairs to the Evansville, Indiana, Pumping Station. Illustrates and describes extensive repairs recently completed. 2200 w. Eng Rec—Dec. 26, 1908. No. 1245.

The Intake Tunnel and Crib of the Lawrence Avenue Pumping Station, Chicago. Illustrated description of this por-

tion of Chicago's sewerage system and its construction. 2500 w. Eng Rec—Dec. 19, 1908. No. 1053.

See also Pumping, under MINING AND METALLURGY, MINING.

Pump Valves.

Researches on the Motion of Automatic Pump Valves (Untersuchung der Bewegung selbsttätiger Pumpenventile). K. Korner. Gives time diagrams for a number of recent types. Ills. 2000 w. Zeitschr d Ver Deutscher Ing—Nov. 14, 1908. No. 1193 D.

Rams.

Hydraulic Rams for Isolated Water Supply. J. S. Lane. An illustrated discussion of hydraulic rams for isolated water supply, their setting, performance, etc. 2500 w. Met Work—Dec. 12, 1908. No. 933.

Turbine Governing.

The Control of the Turbine Under Varying Load (Das Verhalten der Turbine bei verschiedener Belastung). J. Barth. An extensive theoretical and mathematical discussion. Ills. Serial. 1st part. 3500 w. Zeitschr d Oest Ing u Arch Ver—Nov. 6, 1908. No. 1179 D.

Turbine Plants.

Economic Considerations in the Design of Water-Power Plants (Wirtschaftliche Gesichtspunkte beim Veranschlagen von Wasserkraftmaschinen). R. Camerer. A general discussion of a number of important points influencing economy in construction and operation. Ills. 7400 w. Zeitschr d Ver Deutscher Ing—Nov. 28, 1908. No. 1196 D.

Turbine Pressures.

Pressure Fluctuations in Turbine Pipe Lines. Prof. A. Budau. A discussion of devices for pressure regulation and theoretical investigations necessary for safety, with some experiences with long pipe lines. Ills. 9000 w. Jour Assn of Engng Socs—Oct., 1908. No. 781 C.

Surge-Tank Problems (Wasserschlossprobleme). Franz Prásil. Exhaustive mathematical discussion of their design and operation for turbine plants. Ills. Serial. 1st part. 4500 w. Schweiz Bau—Nov. 21, 1908. No. 1158 B.

Turbines.

Absolute Clearance Pressure in Turbines (Das Wesen des Spaltüberdruckes bei Turbinen). N. Baashuus. Mathematical discussion. Ills. 1500 w. Zeitschr f d Gesamte Turbinenwesen—Nov. 30, 1908. No. 1163 D.

Turbine Testing.

Water Measurement in the Turbine Testing Laboratory of the Berlin Technical High School (Watermessungen in der Versuchsanstalt für Wassermotoren an der Königl Techn. Hochschule zu Berlin). Ernst Reichel. Illustrated description of the devices used. 3300 w. Zeitschr d Ver Deutscher Ing—Nov. 14, 1908. No. 1192 D.

MACHINE ELEMENTS AND DESIGN.

Brakes.

Electrically Operated Brakes for Industrial Purposes. H. A. Steen. Considers typical modern designs. Ills. 4000 w. Pro Engrs' Soc of W Penn—Nov., 1908. No. 778 D.

Circle Division.

Table for Spacing Holes in Circles. F. W. Seidensticker. A useful table for dividing circles into parts up to five hundred. 1000 w. Am Mach—Vol. 31. No. 51. No. 1073.

Clutches.

Variable Speed Clutch for Machine Tools. Illustrated description of a clutch to be used as a substitute for cone pulleys and other speed-varying devices. 1000 w. Am Mach—Vol. 31. No. 50. No. 912.

Crank Shafts.

Automobile Motor Crankshafts Discussed. Thomas J. Fay. The present number considers the materials used. Ills. 1500 w. Automobile—Dec. 17, 1908. Serial. 1st part. No. 1028.

The Graphical Design of Crank Shafts (Graphische Berechnung von Kurbelwellen). Adolf Knelles. Mathematical. Ills. 2000 w. Elektrotech Rundschau—Nov. 7, 1908. No. 1184 D.

Flat Plates.

Researches on the Distorsion and Strength of Flat Plates (Versuche über die Formänderung und die Widerstandsfähigkeit ebener Wandungen). C. Bach. Reports extensive tests, the results of which are applicable to both steel and reinforced-concrete construction. Ills. Serial. 1st part. 3800 w. Zeitschr d Ver Deutscher Ing—Nov. 7, 1908. No. 1188 D.

Gear Boxes.

An Eighteen-Speed-Gear Box. C. A. Legge. Line engravings with description. 700 w. Am Mach—Vol. 31. No. 52. No. 1280.

Gears.

The Hindley Worm and Gear. John Edgar. An explanation of the theory of this worm gear. Ills. 2500 w. Mach, N Y—Dec., 1908. No. 761 C.

Generating Gear Teeth of Increased Strength and Standard Hobs. H. T. Miller. Illustrated explanation of modified teeth and the conditions of contact. 1200 w. Am Mach—Vol. 31. No. 49. No. 770.

Journals.

On Journal Friction. H. P. Jordan. A critical discussion of assumptions in a paper by W. H. Scott. 2000 w. Mech Wld—Dec. 4, 1908. No. 1016 A.

The True Principles of Mechanics. Sidney A. Reeve. Discusses the present

insufficiency of the mechanical concepts based on Newton's laws. 3000 w. Engr, Lond—Dec. 18, 1908. No. 1376 A.

Riveted Joints.

See Boiler Design, under STEAM ENGINEERING.

Rope Drums.

Proportions of Rope Drums Without Mathematics. George E. Barrett. Gives a diagram and explains its use. 500 w. Am Mach—Vol. 31. No. 52. No. 1277.

Slide Rules.

The "Eichhorn" Trigonometric Slide Rule. Illustrated description of a new slide rule intended for the solution of triangles. 800 w. Am Mach—Vol. 31. No. 49. No. 771.

How to Use the Slide Rule. Frederic R. Honey. Explains the principle of this invention for rapid computations, and some useful applications. 1200 w. Sci Am—Dec. 19, 1908. No. 1231.

Speed Changing.

See Gear Boxes, under MACHINE ELEMENTS AND DESIGN.

Springs.

Spring Formulae Simplified. Chester B. Albree. An attempt to simplify existing formulae and to render the solution of helical spring problems easy for anyone having standard tables of areas and decimal equivalents at hand. General discussion. 4000 w. Pro Engrs' Soc of W Penn—Nov., 1908. No. 780 D.

Stuffing Boxes.

A New High-Pressure Packing for Rotating Shafts (Eine neue Hochdruckdichtung für rotierende Wellen). Alfred Vontobel. Illustrated description of a type especially adapted for use on turbines. 1600 w. Zeitschr f d Gesamte Turbinenwesen—Nov. 10, 1908. No. 1161 D.

MACHINE WORKS AND FOUNDRIES.

Aluminium Castings.

Production of Aluminum Castings. Illustrates and describes the working of this metal in the foundry. 2500 w. Foundry—Dec., 1908. No. 753.

Boring.

Boring a Connecting-Rod End Brass in a Jig. Henry Munro. Shows a method requiring but three operations. Ills. 1000 w. Am Mach—Vol. 31. No. 51. No. 1071.

Brass Founding.

Observations on the "Spotting-Out" of Lacquered Work, and the Cleaning of Metal for Lacquering. W. A. Jones. Remarks on troubles encountered and their remedies. 2000 w. Brass Wld—Dec., 1908. No. 1324.

Castings.

The Prevention of Waster Castings. Joseph Horner. A discussion of the causes of defective castings. Ills. 2500 w. Foundry—Dec., 1908. No. 755.

Warped or Distorted Castings—Methods of Prevention. Jabez Nall. Suggestions for prevention and for treatment. Ills. 2000 w. Foundry—Dec., 1908. No. 756.

Cupolas.

Cupola Linings. Walter J. May. Directions for setting fire-bricks in a cupola. Ills. 700 w. Prac Engr—Dec. 11, 1908. No. 1201 A.

Latter-Day Cupola Practice. E. E. Riepen. Read before the Detroit Found. Assn. Methods of manipulating and operating the melting furnace of the gray iron foundry. 4500 w. Foundry—Dec., 1908. No. 754.

Drawing-Press Tools.

Press Tools Used in Typewriter Manufacture. Illustrated description of sectional dies employed, and other tools. 1500 w. Am Mach—Vol. 31. No. 52. No. 1279.

Drilling Machines.

German Portable Electric Drilling Machines. Illustrated description of a machine adapted to many uses. 1500 w. Am Mach—Vol. 31. No. 52. No. 1281.

Facing Sands.

Facing Sands and Their Use. Walter J. May. From *Eng. Mech. & Wld. of Sci.* How to obtain variations in faces. 1200 w. Sci Am Sup—Dec. 5, 1908. No. 820.

File Making.

Making Files in a Modern Plant. Illustrates and describes the methods and machinery used by Henry Disston & Sons, Philadelphia. 1200 w. Am Mach—Vol. 31. No. 51. No. 1074.

Foundries.

The Plant of the Standard Cast Iron Pipe & Foundry Co., Bristol, Pa. Illustrated description of a new plant. 2000 w. Eng Rec—Nov. 28, 1908. No. 698.

Foundry Furnaces.

The Air Required for Foundry Furnaces. Walter J. May. Its effect on the efficiency of fuel, with suggestions for securing the best results. 1500 w. Prac Engr—Dec. 4, 1908. No. 1015 A.

Foundry Management.

See Management, under INDUSTRIAL ECONOMY.

Foundry Materials.

See Steel Making, under MINING AND METALLURGY, IRON AND STEEL.

Foundry Practice.

Moulding and Casting (Formen und Giessen). G. Weigelin. A discussion of practical means of producing sound castings. Ills. 3200 w. Stahl u Eisen—Nov. 18, 1908. No. 1146 D.

Grinding.

Grinder Kinks. Paul W. Abbott. Il-

We supply copies of these articles. See page 904.

lustrates and describes a number of tools and fixtures for use on grinding machines. 1500 w. Mach, N Y—Dec., 1908. No. 763 C.

Lathes.

A New Automatic Multiple Spindle Lathe. Illustrates and describes the features of interest. 1500 w. Ir Trd Rev—Dec. 3, 1908. No. 792.

A Heavy 36-In. American Lathe. Illustrated description of a large lathe built at Cincinnati. 1600 w. Ir Age—Dec. 24, 1908. No. 1250.

Precision Lathe for the Finishing of Steam Turbine Rotors (Präzisions-Drehbank zur Fertigbearbeitung von Dampfturbinen-Laufwalzen). Illustrated description with detailed plates of a lathe built for the Vulkan works, Stettin, by Wagner & Co. 500 w. Schiffbau—Nov. 25, 1908. No. 1165 D.

Machine Tools.

Highly Developed Special Machine Tools. Illustrates and describes tools used at the plant of the Hersey Mfg. Co. 2500 w. Am Mach—Vol. 31. No. 49. No. 769.

Messrs. Drummond Brothers' Machine-Tools at Olympia. Illustrated description, especially of the radial foot-drill built by this firm. 2500 w. Engng—Nov. 20, 1908. No. 738 A.

See also Clutches, under MACHINE ELEMENTS AND DESIGN.

Milling Machines.

Vertical Milling Machine. Illustrated description of a new pattern brought out by Messrs. Albert Herbert, Ltd. 800 w. Engng—Dec. 11, 1908. No. 1215 A.

Molding.

The Use of Strickles and Sweeps. James F. Buchanan. A summary of the advantages of these tools in the making of molds and cores. Ills. 2500 w. Foundry—Dec., 1908. No. 757.

Pattern Materials.

See Purchasing, under INDUSTRIAL ECONOMY.

Pipe Tools.

A Group of Useful Pipe-Working Tools. Philip Bellows. Illustrated description of appliances for laying out, heating, bending, testing and inspecting pipe-fittings. 1500 w. Am Mach—Vol. 31. No. 51. No. 1070.

Riveting Machines.

Portable Electro-Hydraulic Riveting Machine (Transportable elektro-hydraulische Nietmaschine). H. Spellmann. Illustrated description of a new electro-hydraulic riveter built by the Maschinenfabrik Oerlikon. 1600 w. Schiffbau—Nov. 25, 1908. No. 1166 D.

Shears.

See Electric Driving, under POWER AND TRANSMISSION.

Shop Appliances.

Details of Manufacturing Equipment. Foundry, machine shop, testing, storage and general details are described and illustrated. 2500 w. Am Mach—Vol. 31. No. 51. No. 1072.

Shop Furniture.

Metallic Shop and Store Room Furniture. Illustrated description of fireproof furniture. 1500 w. Am Mach—Vol. 31. No. 50. No. 909.

Shop Heating.

The Problem of Heating Mills. A. S. Atkinson. Suggestions for the installation of heating systems in factories. 2000 w. Dom Engng—Dec. 19, 1908. No. 1039.

Shop Lighting.

Some Notes on Shop Lighting. W. S. Giele. Discusses the relative advantages of various methods. 1200 w. Wood Craft—Dec., 1908. No. 821.

Shop Practice.

Modern Workshop Practice. R. E. L. Maunsell. Read before the Engng. & Sci. Assn. of Ireland. Briefly discusses changes due to high-speed machine tools and use of high-speed steel. 3000 w. Mech Wld—Dec. 18, 1908. No. 1387 A.

Machining Automobile Pistons. Gives sequence of operations, reviewing the essential points. Ills. 1500 w. Prac Engr—Dec. 18, 1908. No. 1386 A.

Tool Rooms.

Tool Room Methods in a Typewriter Factory. F. A. Stanley. Illustrates and describes special machines used for the construction and maintenance of jigs, fixtures and other tools. 3000 w. Am Mach—Vol. 31. No. 50. No. 911.

Tools.

Metal Cutting Tools Without Clearance. James Hartness. Describes a turning tool that is intended to cut without clearance, stating its advantages. Plates. 4500 w. Jour Am Soc of Mech Engrs—Dec., 1908. No. 837 F.

See also Tool Steel, under MATERIALS OF CONSTRUCTION.

Welding.

Welding. James Cran. Deals principally with welding as it should be done at the forge. Ills. 2500 w. Mach, N Y—Dec., 1908. No. 764 C.

Electric Welding. A. E. Buchenberg. Presents the advantages of the electric welding machine over the forge operation. 2000 w. Elec Wld—Dec. 19, 1908. No. 1272.

The Application of Autogenous Welding to the Repair of Marine Boilers (Emploi de la Soudure autogène pour la Réparation des Chaudières Marines). André Le Chatelier. A general discussion and a description of methods of repairing certain common failures. Ills. 8300 w. Rev de Métal—Nov., 1908. No. 1107 E + F.

We supply copies of these articles. See page 904.

MATERIALS OF CONSTRUCTION.

Alloy Steels.

See Gears, under AUTOMOBILES.

Aluminium.

See Aluminium Castings, under MACHINE WORKS AND FOUNDRIES.

Copper.

Copper and Copper Alloys. J. T. Milton. Abstract of paper read before the Inst. of Metals. Discusses points in relation to these metals, about which reliable information is desired. 4500 w. Mech Engr—Nov. 27, 1908. No. 855 A.

Heat Insulation.

Underground Insulation of Steam and Hot Water Pipes. Harry Gillett. A brief discusson of pipe-coverings. 1200 w. Ohio Soc of Mech, Elec, & Steam Engrs, No. 144—Nov., 1908. No. 907 N.

Metallography.

Microscopic Metallography and Its Employment in French Industries. Jacques Boyer. An illustrated detailed description of the practice followed in the leading establishments. 5500 w. Engineering Magazine—Jan., 1909. No. 1332 B.

Krupp Cemented Armor Plate Under the Microscope (La Corazza "Krupp cementata" esaminata al Microscopio). Ugo F. Gregoretti. A metallographic study. Ills. 5000 w Riv Marit—Nov., 1908. No. 1127 E + F.

See also Cooling Curves, under MEASUREMENT.

Steel.

Heat Treatment of Carbon Steel. J. H. Gill. Describes method and its application. 1200 w. Am Mach—Vol. 31. No. 50. No. 910.

High-Tensile Steel Compared with Mill Steel. Extracts from report of Prof. Archibald Barr concerning an extensive series of experiments recently carried out to determine the relative qualities. 2000 w. Ir & Coal Trds Rev—Dec. 18, 1908. Serial, 1st part. No. 1381 A.

Tool Steels.

The Manufacture and Use of High-Speed Steel. O. M. Becker. Illustrated description of methods of making high-speed tools. 3000 w. Cassier's Mag—Dec., 1908. No. 951 B.

MEASUREMENT.

Calorimetry.

See Steam Calorimeters, under STEAM ENGINEERING.

Cooling Curves.

On Methods of Obtaining Cooling Curves. G. K. Burgess. Explains methods of thermal analysis, the apparatus used, describing experimental arrangements, the characteristics of cooling curves, etc. 7500 w. Bul Bureau of Stand—Nov., 1908. No. 1345 N.

Hardness.

Ballentine's Process of Testing the Hardness and Density of Metals. Report of the Franklin Institute on the process devised by William I. Ballentine. 1200 w. Jour Fr Inst—Dec., 1908. No. 969 D.

Impact Test.

The Resistance of Materials to Impact. T. E. Stanton and L. Bairstow. A report of research work. Ills. 6000 w. Inst of Mech Engrs—Nov. 20, 1908. No. 852 N.

Different Methods of Impact Testing on Notched Bars. F. W. Harboard. A report of experiments made to compare results obtained by different methods of impact testing, and to see whether such tests detected any irregularity in steel not revealed in ordinary tests. 5500 w. Inst of Mech Engrs—Nov. 20, 1908 No. 853 N.

Lubricant Testing.

The Mechanical Testing of Oil (Ueber mechanische Oelprüfung). Dr. H. Hoffmann. Describes methods used in the laboratory of the Westphalian Mining Company and gives some of the results obtained. Ills. Serial. 1st part. 4500 w. Glückauf—Nov. 7, 1908. No. 1151 D.

Testing Laboratories.

The Work of the Reichsanstalt in 1907. Information based upon the official report and on publications of special researches. 3000 w. Engng—Dec. 18, 1908. Serial 1st part. No. 1371 A.

Materials-Testing and Gas-Engine Laboratories of the Darmstadt Technical High School (Die Materialprüfungsanstalt und das Gasmaschinenlaboratorium der Technischen Hockschule zu Darmstadt). O. Berndt. A brief description of their equipment. Ills. 2500 w. Zeitschr d Ver Deutscher Ing—Nov. 21, 1908. No. 1195 D.

Torsion Meters.

Torsion Meters. Frederick T. Edgecombe. Gives some torsion diagrams of marine engines, and results hitherto unpublished. 1300 w. Engr, Lond—Nov. 27, 1908. No. 868 A.

POWER AND TRANSMISSION.

Air Compression.

A Cheap, Efficient Method of Compressing Air. Jos. H. Hart. Discusses mechanical refrigeration as an aid to air compression for mining purposes. 3500 w. Min Wld—Dec. 4, 1908. No. 845.

Air Compressors.

Compressed Air for Mining in Cobalt District. Alex. Gray. Information concerning the Taylor hydraulic air compressor system. Ills. 2500 w. Min Wld—Dec. 12, 1908. No. 1032.

Centrifugal Compressors (Ueber Turbogebläse). C. Regenbogen. Discusses their design, operation, efficiency, etc. Ills. 6300 w. Stahl u Eisen—Nov. 25, 1908. No. 1147 D.

We supply copies of these articles. See page 904.

Belt Driving.

Leather Belting Compared to Rope Drives. John H. Damon. A critical review of paper on this subject by Harrington Emerson. 3500 w. Power—Dec. 22, 1908. No. 1083.

Leather Belting Compared to Rope Drives. Harrington Emerson. Read before the Leather Belting Mfrs. Assn. A comparison of claims made, and discussion of rope and belt transmission. 3500 w. Power—Dec. 1, 1908. No 724.

Electric Driving.

Individual Motor Drive. W. B. Komvenhoven. Some of the advantages of the individual drive are stated and types of motors discussed. 2500 w. Ry & Loc Engng—Dec., 1908. No. 795 C.

Electric Driving of Machine Tools. A. G. Seaman. Abstract of a paper read before the Coventry Engng. Soc. The advantages, efficiency, etc., are discussed. 1500 w. Elect'n, Lond—Dec. 11, 1908. No. 1212 A.

The Application of Motors to Machine Tools. Dexter S. Kimball. Discusses how far the individual drive may be carried with advantage, group driving and matters relating to it, speed control, etc. 4500 w. Mech Engr—Nov. 27, 1908. No. 858 A.

Characteristics of Motors for Large Shears. Brent Wiley. Outlines the conditions which the motor speed characteristics should meet, showing the importance of properly choosing so that the fly-wheel may do the cutting work. 3000 w. Pro Am Inst of Elec Engrs—Jan., 1908. No. 1365 F.

Lubricants.

See Lubricant Testing, under MEASUREMENT.

Mechanical Plants.

Mechanical Power in Country Houses. Illustrated description of an installation near Godalming, giving water supply and electrical equipment. 2200 w. Engng—Dec. 11, 1908. No. 1214 A.

City Investing Building's Power Plant. Thomas Wilson. Illustrated description of a modern plant for a 33-story building having many features of interest. 3500 w. Power—Dec. 15, 1908. No. 1041.

Power Plant and Heating System at U. S. Naval Hospital, New Fort Lyon, Col. A. P. Ball. Brief illustrated description of a plant for a group of buildings. 1200 w. Elec Wld—Dec. 19, 1908. No. 1268.

Power Plant of St. Luke's Hospital, Chicago. Osborn Monnett. Illustrates and describes a plant containing special heating and ventilating features. 2500 w. Power—Dec. 15, 1908. No. 1044.

The Heating, Sanitary and Power Equipment of a Large Office Building. E. B. Lennig. Illustrated description of the systems installed in the eighteen-story Humboldt Savings Bank, San Francisco. 1000 w. Dom Engng—Dec. 5, 1908. No. 872.

Design of a New Heating and Power Plant for the University of Minnesota. Presents the general layout of machines and apparatus for a plant to heat a group of buildings. 2000 w. Minn Engr—Nov., 1908. No. 1361 C.

Power Plants.

The Reorganization of Factory Power Plants. Describes points of importance in such work. 1500 w. Mech Wld—Dec. 18, 1908. Serial. 1st part. No. 1388 A.

Rope Driving.

Rope Driving. Snowden B. Redfield. Considers method of determining the size of rope and other matters relating to rope-driving. 1500 w. Power—Dec. 8, 1908. No. 875.

See also Belt Driving, under POWER AND TRANSMISSION.

Wind Power.

Utilization of Wind Power for Driving Dynamos (Utilisation du Vent comme Force motrice pour Actionner des Dynamos). J. A. Montpellier. A general review of the subject. Ills. 3700 w. L'Elecn —Nov. 28, 1908. No. 1116 D.

STEAM ENGINEERING.

Air Pumps.

Experiments on Air-Pumps. Dr. J. Morrow and J. T. Dixon. Describes experiments made. 2000 w. Engng—Nov. 20, 1908. No. 739 A.

Boiler Design.

Reinforced Openings in Boiler Shells. S. F. Jeter. Directions for calculating manhole reinforcements. Ills. 4000 w. Power—Dec. 22, 1908. No. 1080.

Strength of Riveted Joints. J. W. Rausch. From a lecture at Baltimore, Md. Gives a mathematical determination of the efficiency of various kinds of riveted joints. Ills. 2000 w. Boiler Maker—Dec., 1908. No. 766.

The Strength of Riveted Joints. J. W. Rausch. Explains different causes of failure in lap and butt joints; how to find the pitch, and to estimate the efficiency of plate and joint. 2500 w. Power—Dec. 15, 1908. No. 1042.

Diagram for Finding Efficiency of Riveted Joints. J. P. Morrison. Gives chart and examples illustrating its use. 1700 w. Boiler Maker—Dec., 1908. No. 768.

See also Flat Plates, under MACHINE ELEMENTS AND DESIGN.

Boiler Fittings.

Boiler Fittings. William J. Ranton. Considers only the necessary fittings. 2500 w. Boiler Maker—Dec., 1908. No. 767.

Boiler Inspection.

Steam Boiler Inspection. C. M. Hansen. Gives reasons for the enacting of an

engineer's license law, and the required construction and inspection of boilers. Ills. 2200 w. Boiler Maker—Dec., 1908. No. 765.

Boiler Management.

See Smoke Prevention, under STEAM ENGINEERING.

Boilers.

The Jacobi Boiler and Superheater (Der Jacobi-Kessel und Jacobi-Ueberhitzer). C. Forst. Illustrated description. Serial. 1st part. 1500 w. Die Turbine—Nov. 20, 1908. No. 1159 D.

Boiler Tests.

Tests on Boiler Evaporation at Broken Hill, Block 10. E. F. Stanley Low. Experimental tests to show to what extent the evaporative efficiency could be increased by stoking in such a manner as to increase the percentage of carbon dioxide in the flue gases. Diagrams. 3000 w. Aust Min Stand—Nov. 18, 1908. No. 1094 B.

Boiler Waters.

See Locomotive Feed Water, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Condensers.

Condensers and the Economy of Their Use. Charles L. Hubbard. Discusses the action and economy of the usual types as compared with a non-condensing plant using exhaust steam for heating. Ills. 5000 w. Power—Dec. 22, 1908. No. 1081.

Surface-Condensers for Steam Turbines. An editorial review of a paper by Prof. E. Josse, before the Schiffbautechnische Gesellschaft, on "Surface-Condensation for Steam-Turbines, Especially for Ships." 5000 w. Engng—Dec. 11, 1908. No. 1358 A.

Engine Governing.

Governors and the Speed Regulation of Steam Engines. Prof. G. F. Charnock. Deals particularly with pendulum governors. 2500 w. Mech Engr—Nov. 27, 1908. Serial. 1st part. No. 857 A.

Engine Relief Valves.

Relief Valves. Remarks on their Design. Ills. 1000 w. Mech Wld—Nov. 20, 1908. No. 726 A.

Engines.

The Lanz Locomobile. Illustrated description of an engine exhibited at Olympia which has many unusual features. 1500 w. Engr, Lond—Dec. 4, 1908. No. 1024 A.

See also Steam Engines, under MARINE AND NAVAL ENGINEERING; and Hoisting Engines, under MINING AND METALLURGY, MINING.

Entropy.

The Question of Entropy. A paper by J. Swinburne, replying to a previous paper by Prof. S. A. Reeve, with also a reply by Prof. Reeve to Mr. Swinburne's paper. 6000 w. Harvard Engng Jour—Nov., 1908. No. 1322 D.

Feed-Water Heating.

Means and Methods of Heating the Feed Water of Steam Boilers. Reginald Pelham Bolton. Discusses the economy of heating by live steam, in this second article of a series. Ills. 2000 w. Engineering Magazine—Jan., 1909. No. 1331 B.

Fuel Oil.

Unnecessary Losses in Firing Fuel Oil and an Automatic System for Eliminating Them. C. R. Weymouth. Explains the principle of operation, details of construction, and results in trial of the Moore-Patent automatic fuel oil regulating system. Ills. 6500 w. Jour Am Soc of Mech Engrs—Dec., 1908. No. 839 F.

Fuels.

See Mine Sampling, under MINING AND METALLURGY, COAL AND COKE.

Indicators.

The Hopkinson Flashlight Indicator. Illustrated description of an indicator for high speeds. 800 w. Engng—Dec. 11, 1908. No. 1216 A.

Smoke Prevention.

A Practical Study in Smoke Prevention. H. S. Knowlton. Gives results of recent tests made on a large New England plant, and the remedies suggested. 2200 w. Power—Dec. 29, 1908. No. 1315.

Smokeless Combustion. Charles L. Hubbard. Considers firing and furnace construction in their relation to the prevention of smoke. 2000 w. Elec Rev, N Y—Dec. 5, 1908. Serial. 1st part. No. 823.

Steam Calorimeters.

Steam Calorimeters. Charles N. Cross. Illustrated description of the Barrus "Universal" steam calorimeter and its working. 1200 w. Power—Dec. 29, 1908. No. 1316.

Steam Pipes.

Selection and Safety of Pipe Fittings. A. J. Dixon. Discusses the effect on the safety factor of faulty fittings to steam pipes. 1800 w. Power—Dec. 15, 1908. No. 1043.

The Theory of the Design of Pipes for the Transmission of Saturated and Superheated Steam (Zur Theorie der Berechnung von Rohrleitungen für gesättigte und überhitzte Dämpfe). Dr. M. Wierz. Mathematical. 3000 w. Gesundheits-Ing—Nov. 7, 1908. No. 1169 D.

Steam Properties.

Banki's Steam Diagram (Diagramme de M. Banki pour la Vapeur d'Eau). Translated from *Zeitschrift für das Gesamte Turbinenwesen*. Gives a diagram showing the temperature drop in calories in adiabatic expansion with explanation of its

use. Ills. 2500 w. Rev de Mécan—Nov., 1908. No. 1110 E + F.

Stoking.

Firing Stationary Boilers Economically. F. R. Wadleigh. Suggestions on methods of firing, regulation of air supply; cleaning, kindling and banking fires, and smoke prevention. 7000 w. Power—Dec. 8, 1908. No. 877.

Superheaters.

See Boilers, under STEAM ENGINEERING.

Turbines.

Oerlikon Steam Turbines. Illustrated detailed description of the latest type of these machines. 2200 w. Elect'n, Lond—Dec. 4, 1908. No. 1008 A.

The Development of the Small Steam Turbine. Charles A. Howard. This second, and concluding part discusses the service applications to which this type of prime mover is particularly adapted. 4000 w. Engineering Magazine—Jan., 1909. No. 1327 B.

The Development of Steam Turbines, Particularly of the Impulse Type (Du Développement des Turbines a Vapeur et particulièrement de la Turbine à Action). M. Reuter. Translation from *Zeitschrift des Vereines Deutscher Ingenieure.* Ills. 5000 w. All Indus—Nov., 1908. No. 1118 D.

Steam Turbines of Low Power (Einiges über Dampfturbinen für geringe Leistung). R. Roskowetz. A discussion of their development, types, design, etc. Ills. Serial. 2200 w. Zeitschr f d Gesamte Turbinenwesen—Nov. 10, 1908. No. 1160 D.

See also Stuffing Boxes, under MACHINE ELEMENTS AND DESIGN; Condensers, under STEAM ENGINEERING; and Turbo-Generators, under ELECTRICAL ENGINEERING, DYNAMOS AND MOTORS.

Valve Gears.

Setting the Valves of a Russell Engine. Hubert E. Collins. A study of valve movement of four-valve engine with Meyer cutoff and separate exhaust valves of rotative type. Ills. 3500 w. Power—Dec. 1, 1908. No. 721.

Valves.

Locating and Adjusting Valves. W. H. Wakeman. Remarks concerning gate valves and other types. 1200 w. Power—Dec. 22, 1908. No. 1082.

TRANSPORTING AND CONVEYING.

Auto Trucks.

Application of the Storage Battery to Auto Trucks. Illustrated detailed description of the system in use in the Westinghouse machine shops, Pittsburg. 1800 w. Ir Trd Rev—Dec. 3, 1908. No. 791.

Cableways.

The Employment of Suspension Railways in Ironworks. Illustrates and describes applications showing the adaptability of this system. 1500 w. Engr, Lond—Dec. 18, 1908. No. 1377 A.

A Dock Cableway at the Reiherstieg Shipbuilding and Machine Works, Hamburg (Die Hellingseilbahnanlage der Reicherstieg-Schiffswerft und Maschinenfabrik in Hamburg). Anton Böttcher. Illustrated description of a unique dock installation. 4000 w. Zeitschr d Ver Deutscher Ing—Nov. 14, 1908. No. 1191 D.

Cableway Chariots (Die Klemmapparate der Drahtseilbahnen). A. Pietrokowski. A historical and critical review of various types. Ills. 3500 w. Stahl u Eisen—Nov. 18, 1908. No. 1144 D.

Coal Handling.

Handling Coal by Electric Shovels. Edgar H. Wallington. Illustrates and describes electric cranes of different types. 1200 w. Sib Jour of Engng—Dec., 1908. No. 1350 C.

English Practice in Coal Handling Plants. James A. Seager. General outline of methods employed in Great Britain, with illustrated descriptions of certain devices. 3000 w. Power—Dec. 29, 1908. No. 1314.

Coal-Loading Plant for Japan. Illustrates and describes a novel plant for loading a ship with coal, at the rate of 500 tons per hour. 700 w. Col Guard—Dec. 18, 1908. No. 1367 A.

Conveyors.

Handling Crushed Rock on San Francisco Bay. F. K. Blue. Illustrated description of the belt conveyors and bucket elevators which convey the material to and from bins and load and discharge the hopper barges. 1500 w. Eng & Min Jour—Dec. 12, 1908. No. 965.

Cranes.

The Construction Plant for the Pacific Locks of the Panama Canal. Illustrated description of cantilever cranes. 1200 w. Eng Rec—Dec. 19, 1908. No. 1057.

See also Coal Handling, under TRANSPORTING AND CONVEYING.

Dock Machinery.

See Cableways, under TRANSPORTING AND CONVEYING.

Elevators.

The Operation of Passenger Elevators. Reginald Pelham Bolton. A study of conditions of operation and the effect on service. 3000 w. Pro Am Soc of Civ Engrs—Dec., 1908. No. 1354 E.

Ice Handling.

Ice-Handling Machinery in Ice-Manufacturing Plants. Frank H. Abbey. Illustrates and describes methods and machines. 3000 w. Ice & Refrig—Dec., 1908. No. 997 C.

Industrial Railways.

A Successful Investment in an Industrial Railway. John M. Bruce. Illus-

We supply copies of these articles. See page 904.

trated description of a plant in Newark, N. J., for handling gypsum from steamer to storage yard. 1500 w. Engng-Con—Nov. 25, 1908. No. 714.

Narrow-Gauge Railway for a Gas-Works. Illustrated detailed description of the recently completed line connecting Harrogate with the Northeastern Ry. Co.'s lines at Bilton. 1200 w. Engr, Lond—Nov. 20, 1908. No. 744 A.

MISCELLANY.

Aeronautics.

Fundamental Principles in the Design of Aeroplanes (Grundzüge für den Bau des Drachenfliegers). Josef Hofmann. An exhaustive discussion. Ills. Plates. Serial. 1st part. 5500 w. Oest Wochenschr f d Oeff Baudienst—Nov. 21, 1908. No. 1183 D.

Mechanical Flight. Herbert Chatley. Indicates points in which improvement is desired, reviewing prevailing types. Ills. 4500 w. Soc of Engrs—Dec. 7, 1908. No. 1339 N.

Mechanical Flight. Eric Stuart Bruce. Reviews the work of different experimenters in this field, recent achievements, and related matters. General discussion. 9000 w. Jour Soc of Arts—Dec. 4, 1908. No. 998 A.

Aerial Propellers. Sidney H. Hollands. Discusses old and new forms. 1500 w. Sci Am Sup—Dec. 11, 1908. No. 1233.

The Influence of Combustion Motors on Transport (Influenza dei Motori ad Essenza nell' Industria dei Trasporti). Giuseppe Colombo. Refers principally to their use in airships and aeroplanes. 5500 w. Industria—Nov. 1, 1908. No. 1131 D.

Some Light Engines for Aeroplanes. Illustrates and describes models. 2000 w. Auto Jour—Dec. 12, 1908. No. 1099 A.

Power Generation and Transmission in Aeroplanes. W. F. Bradley and H. W. Perry. An illustrated article discussing the mechanical features of the best-known types. 3000 w. Engineering Magazine—Jan., 1909. No. 1330 B.

Aeroplane-Type Flying Machines. Harry Wilken Perry. Illustrated review of what has been accomplished. 3000 w. Mach, N Y—Dec., 1908. No. 762 C.

The Wright and Vorsin Types of Flying Machine: A Comparison. F. W. Lanchester. Read before the Aërnautical Soc. of Gt. Britain. An account of the performance of both machines, comparing the two systems. 5500 w. Engr, Lond—Dec: 18, 1908. No. 1379 A.

Recent Progress in Aviation (Les Progrès récents de l'Aviation). G. Espitallier. Reviews the work of Wright, Farman and Blériot. Ills. Serial. 1st part. 2800 w. Génie Civil—Nov. 21, 1908. No. 1123 D.

Floating and Flying Navies. J. C. Bayles. An informal discussion of the military value of aerial navigation. 8000 w. Cassier's Mag—Dec., 1908. No. 945 B.

The Possibility of Making Use of Balloons and Motor Air-Ships in the Navy. Trans. from an article by Captain Neumann, in *Marine-Rundschau.* A study of what balloons and motor air-ships are capable of performing, with special reference to their use for naval purposes. 7000 w. Jour Roy United Serv Inst—Nov., 1908. Serial. 1st part. No. 891 N.

The Present Status of Military Aëronautics. George O. Squier. An outline of the present state of mechanical flight. Appendices, bibliography, and 25 plates 28000 w. Jour Am Soc of Mech Engrs—Dec., 1908. No. 836 F.

The Vacuum Airship. G. J. Derb. Calls attention to a possible method of dispensing with hydrogen. 1000 w. Sci Am—Dec. 19, 1908. No. 1230.

Safety Devices.

Safety Appliances on Cotton-Scutchers and Lap-Machines. Explains the dangers to workmen and illustrates and describes appliances for their protection. 2500 w. Engng—Dec. 18, 1908. No. 1369 A.

The Prevention of Accidents in Mechanical Workshops (Contributo alla Prevenzione degli Infortuni nelle Officine meccaniche). F. Massarelli. The first part begins a discussion of hand labor. Ills. Serial. 1st part. 2500 w. Industria—Nov. 22, 1908. No. 1134 D.

MINING AND METALLURGY

COAL AND COKE.

Accidents.

Fatal Accidents in Coal Mines of America. Frederick L. Hoffman. Statistics showing that over 3000 persons were killed in 1907. 3500 w. Eng & Min Jour—Dec. 19, 1908. No. 1051.

Analysis.

The Ultimate Analysis of Coal. Lionel S. Marks. The hydrogen, total carbon, oxygen and nitrogen contents are expressed in curves based on the Government analyses of coal. 1500 w. Power—Dec. 1, 1908. No. 723.

Coal Cutters.

Coal Cutting in Northern Coalfield, England. George R. Dixon. Gives comparison of mining costs and shows that

mining machines have increased the earning power and lessened labor. 1800 w. Eng & Min Jour—Dec. 5, 1908. No. 827.

Coking By-Products.

The Production of Benzol in the Coking of Bituminous Coal (Steinkohlenverkokung und Benzolgewinnung). Dr. Fritz Hönigsberger. Discusses benzol as an automobile fuel and the method of its production in by-product coking. Ills. 5000 w. Zeitschr d Mit Motorwagen-Ver—Nov. 30, 1908. No. 1176 D.

Coking Plants.

Jones & Laughlin's Coke Plant. William L. Affelder. Illustrated description of an installation of 1500 coke ovens in Pittsburg. 3500 w. Mines & Min—Dec., 1908. No. 715 C.

Colorado.

Routt County, Colorado, Coals. R. L. Herrick. A compilation from various sources concerning the geology, deposits, qualities, etc. Ills. 5000 w. Mines & Min—Dec., 1908. No. 719 C.

Electric Power.

Some Applications of Electric Power in Belgium (Quelques Applications de l'Electrotechnique en Belgique). Alfred Lambotte. The fifth part describes the installations of the Société des Charbonnages de Courcelles-Nord. Ills. 6000 w. Soc Belge d Elecns—Nov., 1908. No. 1100 E.

England.

Our Steam Coal and Its Uses. Sir Lees Knowles. From presidential address before the Manchester Geol. & Min. Soc. 4000 w. Col Guard—Dec. 18, 1908. No. 1368 A.

Explosions.

Prevention of Coal Dust Explosions in Mines. William N. Page. Gives reducing the velocity of ventilating currents as an effective remedy. 1500 w. Min Wld—Nov. 28, 1908. No. 710.

Facts Concerning the Marianna Explosion. Floyd W. Parsons. An illustrated discussion of the cause of the accident at this model mine in Pennsylvania. The fan indicator diagram shows that ventilation stopped 25 minutes before the explosion. Also editorial. 4500 w. Eng & Min Jour—Dec. 12, 1908. No. 967.

Germany.

The Geological Structure between Menden and Witten (Beiträge zur Kenntnis des Schichtenaufbaus zwischen Menden und Witten). Herr Kokuk. Illustrated description of the formation in this coal district. 3300 w. Glückauf—Nov. 21, 1908. No. 1152 D.

Mine Dust.

British Coal-Dust Experiments. Gives results of 26 experiments with coal and stone dust at Altofts. Ills. 4500 w. Mines & Min—Dec., 1908. No. 720 C.

Dust as a Factor in Mine Explosions. William N. Page. Considers the watering of mines to be dangerous, and gives recommendations. 1500 w. Eng & Min Jour—Dec. 5, 1908. No. 828.

Mine Fires.

An Underground Fire Disaster. James Ashworth. An account of the disaster which occurred at Hamstead colliery, England. 2500 w. Eng & Min Jour—Nov. 28, 1908. No. 707.

Fighting a Mine Fire at Close Range with Oxygen-Breathing Apparatus. F. W. Gray. Illustrates and describes experience at Sydney No. 1 Mine, Nova Scotia. 1600 w. Mines & Min—Dec., 1908. No 717 C.

Mine Sampling.

Mine Sampling and Chemical Analyses of Coal Tested at the United States Fuel Testing Plant, Norfolk, Va., in 1907. John Shober Burrows. A report of tests. 4000 w. U. S. Geol Surv—Bul. 362. No. 1338 N.

Mine Ventilation.

The Ventilation of Mines. Abstract of a lecture by W. H. Hepplewhite. Considers the splitting of the air current, its vagaries, circulation, etc. 2500 w. Ir & Coal Trds Rev—Dec. 11, 1908. No. 1226 A.

Mining.

The Working of the Inclined Seams in the St. Etienne Coalfield, at the Montrambert and La Beraudiere Collieries. Hugh Clarkson Annett. Abstract of a paper before the N. of England Inst. of Min. & Mech. Engrs. Describes methods of working. 2200 w. Ir & Coal Trds Rev—Dec. 18, 1908. No. 1380 A.

Some Experiments and Improvements in Mining in Austria (Einige Versuche und Verbesserungen beim Bergbau in Oesterreich). Discusses recent practice in coal mining. Ills. Serial, 1st part. 2500 w. Oest Zeitschr f Berg u Hüttenwesen—Nov. 21, 1908. No. 1149 D.

See also Coal Cutting, under COAL AND COKE; and Pumping, and Timber Drawing, under MINING.

Oklahoma.

The Coal Resources of Oklahoma. Charles N. Gould. Information in regard to these deposits. 1200 w. Min Wld—Dec. 12, 1908. No. 1033.

Philippines.

Philippine Coals. Alvin J. Cox. Abstract of a paper in "The Mineral Resources of the Philippine Islands." Gives analyses, steaming tests, and other information. 1200 w. Eng & Min Jour—Nov. 28, 1908. No. 706.

Rescue Appliances.

See Mine Fires, under COAL AND COKE.

Safety Lamps.

The Various Methods of Lighting Safety Lamps (Ueber die verschiedenen Arten

der Sicherheitslampen-Zündung). Herr Beyling. Describes the methods and devices used and discusses their utility and safety. 4500 w. Glückauf—Nov. 28, 1908. No. 1155 D.

Storage.

Storage of Coal Under Water and Tests of the Weathering of Coal. Reports results of experiments and tests. 1200 w. Eng News—Dec. 24, 1908. No. 1243.

Washing.

The Operation of a Coal Washery in Colorado. W. F. Murray. Describes old and new methods. Ills. 1500 w. Eng & Min Jour—Dec. 26, 1908. No. 1275.

Weathering.

See Storage, under COAL AND COKE.

West Virginia.

Coal Fields of West Virginia. H. H. Stoek. The geology of the region with description of the coals, and analyses from different seams. Maps. 3500 w. Mines & Min—Dec., 1908. Serial, 1st part. No. 718 C.

COPPER.

Costs.

Calumet & Hecla Costs. L. S. Austin. Information taken from testimony given in a suit in 1907. 1500 w. Min & Sci Pr—Dec. 19, 1908. Serial, 1st part. No. 1262.

Germany.

Mansfield Electrically Operated Copper Mines. Frank C. Perkins. Illustrated description of German mines where furnace gases are utilized for generating electric power. 2200 w. Min Wld—Dec. 26, 1908. Serial, 1st part. No. 1254.

New Mexico.

Mining and Milling Near Silver City, New Mex. Robert B. Brinsmade. Illustrated description of the development of a district producing gold, silver, copper, lead and zinc. 3500 w. Min Wld—Dec. 26, 1908. No. 1257.

Reduction.

A New Method of Extracting Copper from Its Ores (Ein neus Kupfergewinnungs-Verfahren). Dr. O. Frölich. Describes a leaching process with ferric chloride with subsequent precipitation of copper on iron. Ills. 3300 w. Elektrochem Zeitschr—Nov., 1908. No. 1140 D.

Smelter Stacks.

See Stacks, under CIVIL ENGINEERING, CONSTRUCTION.

Smelting.

Copper-Gold Smelting at Magistral. Robert Linton. Illustrated description of this plant and practice in Mexico, where copper is used as a collector for the precious metals. 2000 w. Min & Sci Pr—Dec. 19, 1908. No. 1261.

Tennessee.

Mines and Works of the Tennessee Copper Co. B. Britton Gottsberger. Illustrated description of the mines and methods. 3500 w. Bul Am Inst of Min Engrs—Nov., 1908. No. 1064 C.

Mining and Smelting in the Ducktown District. Edwin Higgins. Copper and sulphuric acid produced from ore averaging 2 per cent. copper. Ills. 2500 w. Eng & Min Jour—Dec. 26, 1908. No. 1273.

Utah.

Ore Occurrence at Fortuna Mine, Bingham, Utah. Edward R. Zalinski. Illustrated description of the topography, geology, vein system, etc., of this copper mine. 4500 w. Eng & Min Jour—Dec. 19, 1908. No. 1047.

Yukon.

Copper Deposits of White Horse. T. A. Rickard. Information concerning these deposits in the Yukon Territory, and their development. Map. 1400 w. Min & Sci Pr—Dec. 5, 1908. No. 920.

GOLD AND SILVER.

Alaska.

See Placers, under GOLD AND SILVER.

Amalgamation.

Amalgamation Methods. H. W. MacFarren. Discusses methods of different amalgamators. 3000 w. Min & Sci Pr—Dec. 12, 1908. No. 1068.

Australia.

Metallurgical Practice in the Gold Fields of West Australia. Arthur Selwyn-Brown. Gives a summary of the crushing and cyaniding processes adopted for the treatment of difficult ores. Ills. 5000 w. Engineering Magazine—Jan., 1909. No. 1328 B.

Deep Mining at Kalgoorlie, Western Australia. Percy Ifould. Discusses the prospects and possibilities. Ills. 2000 w. Aust Min Stand—Nov. 18, 1908. No. 1091 B.

The Geology of Victorian Gold Occurrence. T. S. Hart. The present number describes the geology of the containing rocks. 3000 w. Aust Min Stand—Nov. 18, 1908. Serial, 1st part. No. 1092 B.

The Deepest Gold Mine in the World. Donald Clark. Information concerning the Victoria Quartz mines, being tested at a depth of 4,525 ft. 2000 w. Aust Min Stand—Nov. 18, 1908. No. 1089 B.

Walhalla and District Mines (V.). Information concerning these auriferous mines with treatment chart. 3500 w. Aust Min Stand—Nov. 11, 1908. No. 1087 B.

The Oaks Goldfield. An illustrated description of the latest auriferous discovery in Queensland. 1200 w. Queens Gov Min Jour—Nov. 14, 1908. No. 1086 B.

We supply copies of these articles. See page 904.

Bolivia.
See Peru, under GOLD AND SILVER.

California.
See Hydraulic Mining, under GOLD AND SILVER.

Colorado.
La Plata Mountains, Colorado. R. H. Toll. Describes a mining region attracting attention, giving information concerning the gold and silver ores. 3300 w. Min & Sci Pr—Nov. 28, 1908. No. 790.

Cyaniding.
See Australia, under GOLD AND SILVER.

Dredging.
Gold-Dredging and Hydraulic Sluicing in Victoria. D. B. Sellars. A report of the work. 2000 w. N Z Mines Rec—Oct. 16, 1908. No. 1001 B.

Dredging on the Seward Peninsula. T. A. Rickard. An account of experience with a number of dredges, discussing the probability of its being profitable. Ills. 5000 w. Min & Sci Pr—Nov. 28, 1908. No. 789.

Gold Value.
Has the Value of Gold Depreciated? Walter Renton Ingalls. Discusses the effect of the cheaper production of gold. 5500 w. Eng & Min Jour—Nov. 28, 1908. No. 703.

Hydraulic Mining.
Practical Methods of Examining and Fitting Up a Hydraulic Mine. H. A Brigham. A review of the methods of hydraulic mining as practiced in California. Ills. 16000 w. Jour Assn of Engng Socs—Oct., 1908. No. 783 C.

San Antonio de Poto Hydraulic Mine, Peru. W. E. Gordon Firebrace. An illustrated account of this famous placer mine. 1200 w. Min & Sci Pr—Dec. 5, 1908. No. 921.

See also Dredging, under GOLD AND SILVER.

Mexico.
See Labor, under MINING.

Nevada.
The Goldfield Type of Ore Occurrence. Robert T. Hill. Describes the peculiar occurrence, said to be due to the action of acidic non-ferruginous vapors incidentally causing alunitization. Ills. 4000 w. Eng & Min Jour—Dec. 5, 1908. No. 825.

Camp Alunite, a New Nevada Gold District. Robert T. Hill. Illustrates and describes a new camp, situated and mineralized like the Goldfield district. 2500 w. Eng & Min Jour—Dec. 19, 1908. No. 1050.

See also Prospecting, under MINING.

New Mexico.
Sylvanite, New Mexico, the New Gold Camp. Fayette A. Jones. Gives the history of a district that has been worked for turquoise, lead, and copper, and now for gold. Ills. 1500 w. Eng & Min Jour—Dec. 5, 1908. No. 826.

See also same title, under COPPER.

New Zealand.
The Future of New Zealand's Alluvial Goldfields. Considers the available ground and its value, methods and machinery, and the personal factor. 4000 w. Min Jour—Nov. 21, 1908. No. 734 A.

See also Dredging, under GOLD AND SILVER.

Patio Process.
The Patio Process. C. Perez Duarte. An explanation of the theory of this Mexican amalgamation process. 5000 w. Jour Chem, Met, & Min S of S Africa—Oct., 1908. No. 1084 E.

Peru.
The Goldfields of Eastern Peru and Bolivia. Sir W. Martin Conway. Map and description, with general discussion. 8000 w. Jour Soc of Arts—Nov. 27, 1908. No. 848 A.

See also Hydraulic Mining, under GOLD AND SILVER.

Placers.
Mining Methods in the North. T. A. Rickard. Traces the evolution of methods of mining gold-bearing gravel in Alaska. Ills. 3000 w. Min & Sci Pr—Dec. 12, 1908. Serial, 1st part. No. 1067.

See also Prospecting, under MINING.

Wyoming.
The South Pass Gold Mining District, Wyoming. Henry C. Beeler. History of the early mining and development, describing the ores and treatment. 3500 w. Min Wld—Dec. 26, 1908. No. 1256.

IRON AND STEEL.

Alabama.
Iron Operations of the Birmingham District. Edwin Higgins. Describes the deposits and the methods of mining, the smelting, and the economic and industrial conditions. Ills. 4000 w. Eng & Min Jour—Nov. 28, 1908. No. 704.

Iron Operations in Northeastern Alabama. Edwin Higgins. Illustrated description of practice in mining the thin red-ore seams and brown-ore banks, and of features of iron blast-furnace operation. 2500 w. Eng & Min Jour—Dec. 5, 1908. No. 824.

Analysis.
A Rapid Method for the Analysis of Tin and Terne Plate. R. S. Hiltner, in *West. Chem. & Met.* Gives specifications and methods of analysis, with details of the recommended method. 2500 w. Min Jour—Dec. 12, 1908. No. 1204 A.

The Standardization of Potassium Permanganate Solution and Its Subsequent Use in Titrating Iron. Cornelis Offerhaus and Ernest H. Fischer. An account of the writers' experience with standards

We supply copies of these articles. See page 904.

for this solution. 1200 w. Sch of Mines Qr—Nov., 1908. No. 975 D.

Bessemer Process.

The Basic Bessemer Plant at the Burbach Works (Das neue Thomasstahlwerk der Burbacher Hütte). F. Schroeder. Illustrated description. Plates. 11000 w. Stahl u Eisen—Nov. 11, 1908. No. 1142 D.

The New Basic-Bessemer Steel Plant at the Burbach Works. F. Schröder, in *Stahl und Eisen.* Illustrated detailed description of the plant and its equipment. 2500 w. Ir & Coal Trds Rev—Dec. 11, 1908. Serial, 1st part. No. 1224 A.

China.

The Iron Industry in the Yangtse-Kiang Valley. Information concerning the mineral wealth and of the works of the Hanyang Iron & Steel Co. 1200 w. Ir & Coal Trds Rev—Nov. 20, 1908. No. 747 A.

Dry-Air Blast.

Gayley's Invention of the Dry Blast. Rossiter W. Raymond. Read at Chattanooga meeting of the Am. Inst. of Min. Engrs. Discusses the value of this invention and its commercial economy. 4000 w. Eng & Min Jour—Dec. 19, 1908. No. 1049.

Refrigeration Applied to Air Supply for Blast Furnaces. Bruce Walter. Read before the Am. Soc. of Refrig. Engrs. Describes the refrigerating apparatus for the Isabella Plant of the U. S. Steel Corporation, and states the advantages. 2500 w. Cold Storage & Ice—Dec., 1908. No. 992 C.

Electro-Metallurgy.

The Electro-Metallurgy of Iron (L'Electrosiderurgie). Charles Le Chatelier. Comments on, and abstracts of, recent publications on the purification of steel in the electric furnace and on the general progress of the electro-metallurgy of iron. Ills. 6500 w. Rev de Métal—Nov., 1908. No. 1109 E + F.

Progress in the Electro-Metallurgy of Iron and Steel (Die weiteren Fortschritte der elektrischen Eisen- und Stahlgewinnung). Dr. Albert Neuburger. A review of progress in electric-furnace design and applications. Ills. Serial, 1st part. 4700 w. Glasers Ann—Nov. 15, 1908. No. 1168 D.

See also same title, under ELECTRICAL ENGINEERING, ELECTRO-CHEMISTRY.

Harmet Process.

The Harmet Process Applied to Open-Hearth Steel at the "Deutscher Kaiser" Works, Bruckhausen (Das Harmetverfahren im Martinbetriebe der Gewerkschaft "Deutscher Kaiser" in Bruckhausen). Illustrated description of methods, appliances and results. 6500 w. Stahl u Eisen—Nov. 4, 1908. No. 1141 D.

Italy.

The Iron and Steel Industries of Italy. Abstract of a paper by M. P. Nicou. A review of deposits, production, imports, exports, etc. 2500 w. Ir & Coal Trds Rev—Dec. 11, 1908. No. 1225 A.

New York.

Stripping Clinton Iron Ore in New York State. Edwin Higgins. Describes these hematite beds and their development. Ills. 2000 w. Eng & Min Jour—Dec. 12, 1908. No. 964.

Open Hearth.

See Harmet Process, under IRON AND STEEL.

Rolling Mills.

The Continuous Sheet Mill Patents. The decision in the Donner-Bray infringement case. 4000 w. Ir Age—Dec. 17, 1908. No. 1036.

New Gas-Driven Rolling-Mill Plant at Mossend Works. Illustrated description of the gas plant for new rolling-mill engines and furnaces, at these large works near Glasgow. 4000 w. Engng—Nov. 27, 1908. No. 865 A.

Electrically-Driven Reversing Roll Trains (Ueber elektrische Umkehr-Walzenstrassen). B. K. Lambrecht. An exposition of driving methods. Ills. 2000 w. Stahl u Eisen—Nov. 18, 1908. No. 1143 D.

New Portable Roll Ways (Neuere fahrbare Hebetische). Illustrated description of recent conveying devices for rolling mills. 2400 w. Stahl u Eisen—Nov. 18, 1908. No. 1145 D.

See also Gas Engines, under MECHANICAL ENGINEERING, COMBUSTION MOTORS.

Sheets.

See Rolling Mills, under IRON AND STEEL.

Steel Making.

Steel by the Direct Process. Oscar Stromborg. Describes a method of charging carbon below the surface of the molten bath. 2500 w. Ir Age—Dec. 24, 1908. No. 1251.

The Manufacture of Steel for Castings. Dr. Bradley Stoughton. Read before the Pittsburg Found. Assn. A discussion of the different processes of making steel for castings, comparing them as to quality, cost, etc. Ills. 5000 w. Ir Trd Rev—Dec. 17, 1908. No. 1038.

Steel Works.

New Steel Works in the United States. The present number gives an illustrated description of the Saucon Works of the Bethlehem Steel Co. 3500 w. Engr, Lond—Nov. 20, 1908. Serial, 1st part. No. 742 A.

The Keystone Works of the Jones & Laughlin Steel Company. A new plant at Pittsburg, Pa., is illustrated and de-

scribed. 1600 w. Eng Rec—Dec. 12, 1908. No. 960.

See also Bessemer Process, under IRON AND STEEL.

Tariff.

See same title, under INDUSTRIAL ECONOMY.

Trade.

Progress of the Iron and Steel Industry. P. N. Cunningham. Presidential address reviewing the progress of the iron and steel industry in the West of Scotland for the last 30 years. Plate. 7500 w. Jour W of Scotland Ir & Steel Inst—Oct., 1908. No. 894 N.

The World's Export Trade in Iron and Steel and Its Regulation. Harold Jeans. Read before the Staffordshire Iron & Steel Inst. Discusses the internal working in the various countries in the present number. 6500 w. Ir & Coal Trds Rev—Nov. 27, 1908. Serial, 1st part. No. 871 A.

LEAD AND ZINC.

Lead Smelting.

Smelting Practice at Granby Works, Missouri. Evans W. Buskett. Scotch hearth furnaces are used to smelt lead concentrates. Treatment of smelter fumes with recovery of lead in quantity. 1700 w. Min Wld—Dec. 19, 1908. No. 1065.

New Mexico.

See same title, under COPPER.

MINOR MINERALS.

Aluminium.

Aluminium as a Factor in the Electrical Industry. The present number briefly considers its use both for electrical purposes and in other ways. 2500 w. Elect'n, Lond—Nov. 27, 1908. Serial. 1st part. No. 862 A.

Cement.

I. Manufacture of Portland Cement from Materials High in Magnesia. Richard K. Meade. II. The Effect of Magnesia on Portland Cement. Dr. Rudolph Dyckerhoff. Two important articles on the permissible quantity of magnesia. 3000 w. Cement Age—Dec., 1908. No. 1321.

Diamonds.

Researches in Diamond Making. F. H. Mason. An account of the experimental work of Richard Threlfall. 1200 w. Min & Sci Pr—Dec. 5, 1908. No. 919.

Manganese.

Manganese Ore in Arkansas. E. C. Harder. Brief description of the deposits and their development. 3500 w. Min Wld—Dec. 26, 1908. No. 1255.

Manganese Deposits of Morro da Mina, Brazil. Joquim Lustosa and J. C. Branner. Brief illustrated description of these deposits and their development. 1500 w. Eng & Min Jour—Dec. 19, 1908. No. 1048.

A Manganese Deposit in Southern India. R. O. Ahlers. Describes particularly the deposits of the State of Sandur, Bellary District, in the north of Madras Presidency. 4000 w. Inst of Min & Met, Bul. No. 50—Nov. 12, 1908. No. 893 N.

Nickel.

Notes on Nickel. Prof. A. Humboldt Sexton. Considers its properties, compounds, minerals, etc., in the present number. 2000 w. Mech Engr—Nov. 27, 1908. Serial. 1st part. No. 854 A.

Oil.

Oil Field at Follansbee, W. Va. Frank W. Brady. Gives the location of the wells, with history of the development, production, etc. 3000 w. Mines & Min—Dec., 1908. No. 716 C.

Notes on the Oil and Gas Industry. Describes the geology of the deposits, giving the history and development of the industry. Map. 2400 w. Min Wld—Nov. 28, 1908. No. 708.

Mexican Petroleum: The Tuxpan Oil Well Fire. Henry Floy. Information in regard to the oil situation in Mexico, and account of the fire which burned without intermission for three months. 1800 w. Eng News—Dec. 10, 1908. No. 937.

The Petroleum-Bearing Zone of Northern Peru. V. F. Masters. The geology of the region and conclusions from the study are given in the present number. 2500 w. Min Jour—Nov. 21, 1908. Serial. 1st part. No. 735 A.

Phosphate.

Phosphate Mining in Florida (L'Exploitation des Phosphates de la Floride). A general review of methods of mining and ore treatment, production, etc. Ills 2100 w. Génie Civil—Nov. 21, 1908. No. 1125 D.

Salt.

Magnitude of the Salt Industry. Gives graphical illustrations, and calculations of salt production. 1800 w. Sci Am—Dec. 26, 1908. No. 1292.

The Pumping of Brine, and the Manufacture of Common Salt. Philip Morris Pritchard. Describes the more usual methods of obtaining brine and of manufacturing white salt. Ills. 6500 w. Inst of Civ Engrs—No. 3725. No. 885 N.

Tantalum.

The Properties, Metallurgy and Uses of Tantalum (Propriétés, Métallurgie et Emploi du Tantale). Pierre Breuil. The first part discusses the tantalum minerals. Serial. 1st part. 2000 w. Génie Civil—Nov. 7, 1908. No. 1121 D.

Tin.

The Red River, Cornwall. Brief account of trouble due to tailings from the tin mines. 1000 w. Min & Sci Pr—Dec. 19, 1908. No. 1263.

The Occurrence of Stannite in Austral-

We supply copies of these articles. See page 904.

asia. Hartwell Conder. Information, with analysis and methods of treatment. 1800 w. Aust Min Stand—Nov. 18, 1908. No. 1095 B.

See also same title, under ORE DRESSING AND CONCENTRATION.

Tungsten.

Wolfram Ores—Occurrences and Uses. Charles Bogenrieder. Discusses their importance in Australia and to commerce in general. 1000 w. Aust Min Stand—Nov. 18, 1908. Serial. 1st part. No. 1090 B.

Tungsten Ore Deposits of the Coeur d'Alene. Herbert S. Auerbach. Undeveloped deposits carrying 25% tungsten trioxide are described. Schulite occurs associated with gold, silver, lead, iron, and copper. 2000 w. Eng & Min Jour—Dec. 12, 1908. No. 963.

MINING.

Accidents.

See Law, under MINING.

Air Compression.

See same title, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

Blasting.

The Theory of Blasting with High Explosives. E. M. Weston. Gives results of the writer's study of this subject. 8000 w. Jour Chem, Met, & Min Soc of S Africa—Oct., 1908. No. 1085 E.

Costs.

See same title, under COPPER.

Drilling.

See Prospecting, under MINING.

Electric Power.

See Germany, under COPPER.

Haulage.

Haulage with Compressed-Air Locomotives in the Emo Mine of the Cologne Mining Company (Die Druckluft-Lokomotivförderung unter Tage auf den Emscherschächten des Kölner Bergwerks-Vereins). D. Winkhaus. Describes the equipment and methods and gives costs of operation and maintenance. Ills. 2500 w. Glückauf—Nov. 28, 1908. No. 1154 D.

Hoisting Engines.

A Twin Tandem-Compound Drop-Valve Winding Engine. Illustrated description of engine built in Germany. 1200 w. Engr, Lond—Dec. 11, 1908. No. 1222 A.

Hoisting Ropes.

Stresses on Winding and Conducting Ropes as Used in Mine Shafts. Joseph Hindley and John Stoney. Read before the Manchester Geol. & Min. Soc. Gives plan and description of a stress indicator. 1500 w. Ir & Coal Trds Rev—Dec. 18, 1908. No. 1382 A.

Hydraulic Mining.

See same title, under GOLD AND SILVER.

Labor.

Mine Labor and Supplies in Mexico. Mark R. Lamb. An explanation of labor conditions and description of how the work is done. Ills. 2000 w. Eng & Min Jour—Dec. 26, 1908. No. 1274.

Law.

Assessment Work on Mining Claims. William E. Colby. A brief explanation of the nature of the annual labor required by the U. S. mining laws. 2000 w. Min & Sci Pr—Dec. 12, 1908. No. 1066.

Prevention of Mine Accidents. Investigations made by a committee appointed by the Am. Min. Cong. shows that only four states have comprehensive laws regulating metalliferous mining. 13000 w. Eng & Min Jour—Dec. 5, 1908. No. 913.

Locomotives.

Compressed Air Mine Locomotives. Illustrated description of a locomotive introduced by the Berliner Maschinenbau-Actiengesellschaft, to be driven by compressed air. 700 w. Ir & Coal Trds Rev—Dec. 4, 1908. No. 1027 A.

See also Haulage, under MINING.

Miners' Clubs.

The Cactus Club at the Newhouse Mines, Utah. Lafayette Hanchett. An account of a coöperative organization controlled by the mine employees which has proved successful. Ills. 800 w. Eng & Min Jour—Dec. 19, 1908. No. 1046.

Mine Waters.

Methods Used in Sealing Off Underground Water. Edmund B. Kirby. Method of injecting clay, or other solid, into flowing water is described. 1800 w. Min Wld—Nov. 28, 1908. No. 709.

Prospecting.

Prospectors and Prospecting in Nevada. Robert T. Hill. Suggestions for aids in prospecting are given in the present article. 1500 w. Eng & Min Jour—Nov. 28, 1908. Serial. 1st part. No. 705.

A Scientific Search for a New Goldfield. Robert T. Hill. An illustrated account of scientific prospecting which led to the discovery of a new gold district in Nevada. 2500 w. Eng & Min Jour—Dec. 12, 1908. No. 966.

The Hand Drill in Prospecting Placer Deposits. John Power Hutchins. Discusses the advantages and disadvantages as compared with steam-drill prospecting, the methods of drilling, especially with rotation of casing. 4000 w. Eng & Min Jour—Dec. 12, 1908. No. 962.

Pumping.

The Arrangement of Pumps for Modern Collieries. J. S. Barnes. Illustrates and describes the Hathorn-Davey pumps and the general arrangement of a recent plant. 2800 w. Ir & Coal Trds Rev—Dec. 4, 1908. Serial. 1st part. No. 1026 A.

We supply copies of these articles. See page 904.

Shaft Sinking.

Vertical Shaft Sinking—Buckets v. Skips. Charles B. Saner. Discusses both systems, favoring the latter. General discussion. 4000 w. Jour S African Assn of Engrs—Oct., 1908. No. 1002 F.

Method of Refrigeration in the Sinking of Shafts. Samuel K. Patterson. Describes a method used in England in sinking a 490-ft. shaft through quick-sand, without the aid of pumps. 1500 w. Min Wld—Dec. 5, 1908. No. 844.

Surveying.

A Note on Running Levels Underground (Ein Beitrag zur Ausführung von Nivellements in der Grube). Viktor Kadainka. Illustrates and describes a new device for approximate work. Serial. 1st part. 1500 w. Oest Zeitschr f Berg u Hüttenwesen—Nov. 7, 1908. No. 1148 D.

Timber Drawing.

Timber Drawing at the Julius III Mine, Brüx (Ueber das Stempelrauben mittels Raubwinde im Kammerbruchbau des k.k. Schachtes Julius III zu Brüx). Gustav Ryba. Illustrates and describes a machine for drawing timber from worked-out rooms. Serial. 1st part. 2200 w. Oest Zeitschr f Berg u Hüttenwesen—Nov. 28, 1908. No. 1150 D.

Ventilation.

See Mine Ventilation, under COAL AND COKE.

ORE DRESSING AND CONCENTRATION.

Gold Milling.

See Australia, under GOLD AND SILVER.

Tin.

Notes on Tin Dressing. H. W. Hutchin. An account of a series of tests whose object was to determine the losses in connection with tin dressing. Ills. 4500 w. Inst of Min & Met, Bul. No. 50—Nov. 12, 1908. No. 892 N.

MISCELLANY.

Alloys.

The Alloys of Nickel (Les Alliages de Nickel). A. Portevin. Summary of Prof. Tammann's researches on alloys of nickel with bismuth, cadmium, cobalt, chromium, antimony, silicon, tin, lead, thallium and zinc. Ills. 4000 w. Rev. de Métal—Nov., 1908. No. 1108 E + F.

Canada.

A Visit to the Mineral Districts of Canada. William Frecheville and Hugh F. Marriott. Notes on an excursion organized by the Canadian Mining Institute, describing the districts visited. 1000 w. Inst of Min & Met, Bul. 51—Dec. 10, 1908. No. 1340 N.

Notes on Plant in the Mining Districts of Canada. R. E. Commans. A general idea of the plant at mines visited during the excursion organized by the Canadian Institute. 7000 w. Inst of Min & Met, Bul. 51—Dec. 10, 1908. No. 1341 N.

Great Britain.

Our Mineral Statistics. A review of the Mines and Quarries. General Report and Statistics for 1907, with the exception of the coal and iron trades. 3000 w. Eng'r, Lond—Nov. 20, 1908. No. 741 A.

Jamaica.

Mineral Deposits of Jamaica in West Indies. Francis C. Nicholas. Nearly all the common minerals are found. Ocher and clay give promise of becoming important. 2000 w. Min Wld—Dec. 12, 1908. No. 1034.

Mineral Springs.

The Eruption of the Waimata Mud-Springs. James Henry Adams. Describes the location and discusses the probable origin of the springs. 3 maps. 2800 w. N Z Mines Rec—Oct. 16, 1908. No. 1000 B.

Ore Deposits.

See Nevada, under GOLD AND SILVER.

South Carolina.

The Mines of South Carolina. H. L. Scaife. Information concerning the mineral occurrence and workings, with bibliography. 2000 w. Eng & Min Jour—Dec. 19, 1908. No. 1052.

United States.

See Natural Resources, under INDUSTRIAL ECONOMY.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Automatic Stops.

See Signalling, under CONDUCTING TRANSPORTATION.

Signaling.

Trial of the Rowell-Potter Block Signals and Automatic Stop. Illustrated account of a system of automatic train control under trial on the C. B. & Q. R. R. 1800 w. Ry & Engng Rev—Dec. 26, 1908. No. 1282.

Wire Transmissions Laid in Pipes Filled with Oil for Operating Switches and Signals. L. Dufour. Describes this system of construction as installed at Grypskerk station, Holland. Ills. 1300 w. Bul Int Ry Cong—Nov., 1908. No. 897 G.

Train Dispatching.

The A B C System of Train Dispatching. A. Beamer. Describes this system as used on the Northern Pacific Ry. 2200 w. Ry & Loc Engng—Dec., 1908. No. 796 C.

We supply copies of these articles. See page 904.

Trains.

New Royal Train, Great Northern Railway. Illustrated description of fine special saloons for the use of the King of England. 700 w. Engng—Nov. 27, 1908. No. 869 A.

MOTIVE POWER AND EQUIPMENT.

Air-Brakes.

Southern Pacific Air Brake Tests. Abstract of a report, illustrating in detail the present state of air-brakes and their operation. Also editorial. Ills. 8000 w. R R Age Gaz—Dec. 4, 1908. Serial. 1st part. No. 805.

Brakes.

Brake Shoe Friction. G. W. Kiehm. Explains the results of forcing a brake-shoe against a revolving wheel. 2000 w. Ry & Loc Engng—Dec., 1908. No. 794 C.

Electrification.

Electric Traction on Steam Railroads. Edwin B. Katte. From a lecture delivered at Harvard University. Remarks on the advantages of electric operation, the systems commonly used, and the electrification recently installed on the N. Y. C. & H. R. R. R. 3000 w. Sib Jour of Engng—Dec., 1908. No. 1351 C.

The Proposed Change to Electric Traction at the Chicago Terminal of the Illinois Central R. R. From a report by a special committee in connection with smoke abatement. Outlines the present situation, and discusses questions relating to the electrification. 2500 w. Eng News—Dec. 24, 1908. No. 1238.

The Log of the New Haven Electrification. W. S. Murray. Aims to bring the actual operation of the New Haven single-phase electrification as closely as possible to those interested in its merits and faults. Ills. 10000 w. Pro Am Inst of Elec Engrs—Dec., 1908. No. 841 F.

Notes Taken During a Journey of Enquiry in the United States. Em. Uytborck. Principally an illustrated description of the electrification of the N. Y. C. & H. R. and the N. Y., N. H. & H. lines and their equipment, with criticism and comparison. 21500 w. Bul Int Ry Cong—Nov., 1908. No. 896 G.

Freight Cars.

Large Railway Wagons. From the presidential address of Jas. Hewitt, at meeting of the Jun. Gas Engng. Assn. Deals with the construction of large railway wagons and their use at gas-works. 2500 w. Col Guard—Nov. 20, 1908. No. 737 A.

Locomotive Boilers.

The Relation of the Brick Arch to the Efficiency of the Present Day Locomotive Boiler. George Wagstaff. Explains the advantages of the brick arch, considering its disadvantages have been largely overcome. General discussion. 7000 w. Pro Cent Ry Club—Nov. 13, 1908. No. 1298 C.

The Brotan Locomotive Boiler. Illustrated description of a new engine without copper plates and braces. 1500 w. Sci Am Sup—Dec. 19, 1908. No. 1235.

Locomotive Feed Water.

A Large Water Softener. Illustrates and describes a plant designed to deal with 30,000 gals per hour. 1200 w. Engr, Lond—Dec. 11, 1908. No. 1223 A.

Locomotive Flues.

Endurance of Locomotive Flue Material. Alex. Kearney. From the address before the Richmond Ry. Club. A report of investigations of this material and the causes of its deterioration. Ills. 3500 w. Ry & Engng Rev—Nov. 28, 1908. No. 702.

Locomotive Frames.

Frame Failures on Modern Locomotives. F. P. Roesch. Discusses the causes and the remedy. 3000 w. Ry & Loc Engng—Dec., 1908. No. 798 C.

Frame Failures. C. G. Rommel. Discusses points relating to such failures and the repairs. 1500 w. R R Age Gaz—Dec. 4, 1908. No. 807.

Locomotive Performances.

Great Western Six-Coupled Express Locomotive Work. An account of work done by these engines which have proved very satisfactory. 4500 w. Engr, Lond—Dec. 4, 1908. No. 1023 A.

Locomotives.

Articulated Compound Locomotives. C. J. Mellin. An illustrated study of the design and construction of engines of the Mallet articulated type, with related information. 6000 w. Jour Am Soc of Mech Engrs—Dec., 1908. No. 838 F.

Locomotives for the A. T. & S. F. Describes engines comprising a recently completed order, illustrating the Pacific (4-6-2) engine. 1000 w. Ry & Loc Engng—Dec., 1908. No. 797 C.

Engines for the Associated Lines. Information concerning the engines for the Harriman Lines, illustrating and describing the 4-4-2 engine for the Sonora Ry., and the 2-6-0 engine for the Cananea Yaqui River & Pacific. 1500 w. Ry & Loc Engng—Dec., 1908. No. 793 C.

Four-Cylinder Compound Locomotive, Hungarian State Railways. Illustrated detailed description of the Atlantic type balanced compound express engine, adopted as the standard type. 2000 w. Engr, Lond—Nov. 27, 1908. No. 870 A.

Six-Coupled Locomotive for the North Brabant Railway. Illustration with particulars. 200 w. Engng—Nov. 27, 1908. No. 866 A.

Compound Locomotive with Pielock Superheater and Lentz Valves. Illustrated description of an engine for the

Malmö-Ystad Railway, Sweden. 700 w. Engng—Dec. 11, 1908. No. 1217 A.

The Locomotives of the Gotthard Railway (Die Lokomotiven der Gotthardbahn). M. Richter. A historical study. Ills. Serial. 1st part. 5500 w. Zeitschr d Ver Deutscher Ing—Nov. 14, 1908. No. 1190 D.

Locomotive Smoke.

Report of Chicago Smoke Inspection. Dept. on Abatement of Locomotive Smoke. From a bulletin issued by G. E. Ryder, giving facts based upon recent locomotive tests. Ills. 2000 w. Ry & Engng Rev—Nov. 28, 1908. No. 701.

Motor Cars.

Railway Motor Car for Siam. Illustrations of this oil-engine car with brief description. 500 w. Engr, Lond—Dec. 4, 1908. No. 1025 A.

Accumulator Cars of the Prussian State Railways. An illustrated description of the electrical equipment of these cars. 2200 w. Tram & Ry Wld—Dec. 3, 1908. No. 1203 B.

Two-Class Accumulator Cars of the Prussian State Railways (Akkumulatordoppelwagen der preussischen Staatsbahn-Verwaltung). D. Hönsch. Illustrated description of a car to accommodate 100 passengers. 3000 w. Glasers Ann—Nov. 1, 1908. No. 1167 D.

Passenger Cars.

New Types of Broad Gauge Underframes and Bogies. Illustrated descriptions of types for the Indian State Railways. 1000 w. Engr, Lond—Nov. 20, 1908. No. 745 A.

Refrigeration.

A Movable Refrigerating Plant for Pre-Cooling. S. J. Dennis. Read before the Am. Soc. of Refrig. Engrs. An illustrated description of the refrigerating car. 1500 w. Cold Storage & Ice—Dec., 1908. No. 993 C.

Train Lighting.

History of Axle Lighting. W. L. Bliss. Abstract of a paper read before the Assn. of Car Lighting Engrs. 2000 w. Elec Rev, N Y—Dec. 19, 1908. Serial. 1st part. No. 1062.

Wheels.

Flat-Spots on Car Wheels. Prof. Charles H. Benjamin. Illustrates and describes an apparatus for testing such wheels and determining the impact due to flat spots, and the rail deflection. General discussion. 7500 w. Pro W Ry Club —Nov. 17, 1908. No. 1299 C.

PERMANENT WAY AND BUILDINGS.

Earth Slides.

See Washouts, under PERMANENT WAY AND BUILDINGS.

Elevated Railways.

Proposed Structural Improvements for the Elevated Terminal Loops at Chicago. Considers details of construction and equipment suggested in a recent report of Charles K. Mohler. 4000 w. Eng News —Dec. 17, 1908. No. 983.

Freight Warehouses.

The Steele-Wedeles Company's Warehouse in Chicago. Illustrates and describes a warehouse serving as a central receiving and distributing station for the freight tunnel system, as well as for an extensive wholesale grocery business. 2500 w. Eng Rec—Dec. 12, 1908. No 957.

Rails.

Effect of Flat Wheels on Rails. H. H. Vaughan. A mathematical analysis. 1000 w. Am Engr & R R Jour—Dec., 1908. No. 847 C.

Rolled Manganese Steel Rail. Gives a report of tests made of rolling rails of different analyses. Ills. 1200 w. R R Age Gaz—Dec. 11, 1908. No. 924.

Stations.

The New Scranton Station of the Delaware, Lackawanna & Western Railroad. Illustrated description of the facilities of this fine station and office building. 2000 w. Eng Rec—Nov. 28, 1908. No. 694.

Glasgow Central Station Extension. Donald A. Matheson. Abstract of a paper read before the Inst. of Civ. Engrs. Describes the reconstruction and equipment to meet modern requirements. 2200 w. Engng—Nov. 20, 1908. No. 740 A.

Terminals.

Railway Terminals. Illustrated description of the extensive terminal improvements in progress in New York City. 4000 w. Sci Am—Dec. 5, 1908. No. 817.

Recent Work on the New York Terminal of the New York Central Railroad. Illustrates and describes details of difficult reconstruction. 2000 w. Eng Rec—Dec. 19, 1908. No. 1060.

A Rail and Water Freight Terminal at Bristol, England; Great Western Ry; Illustrated description of interesting work for the extension of terminal facilities. 1500 w. Eng News—Dec. 10, 1908. No. 936.

Track Construction.

Track Superstructure on German Railways (La Superstructure des Voies des Chemins de Fer Allemande). M. Blum. Illustrates and describes types of ties, rails, rail joints, etc. 6000 w. Rev Gen d Chemins de Fer—Nov., 1908. No. 1111 G.

Washouts.

Railway Slides and Washouts. Abstract of a circular issued by the Roadway Committee of the Am. Ry. Engng. & Main. of Way Assn. Causes and remedies are discussed. 1500 w. Eng News—Dec. 10, 1908. No. 940.

We supply copies of these articles. See page 904.

TRAFFIC.

New York.

Freight Distribution by Subway. Brief illustrated description of a system proposed for New York City. 1500 w. Sci Am—Dec. 5, 1908. No. 818.

Review.

Review of Traffic Questions. C. Colson. The results of working the railways during 1906 in France, England, Germany and the United States; the situation in 1907. 2200 w. Bul Int Ry Cong—Nov., 1908. No. 898 G.

MISCELLANY.

Accounting.

Railroad Accounting and the Hepburn Law. Arthur C. Graves. Brief review of the recent railway reports and the information given, with an examination of the provisions of the Hepburn Act. 1500 w. R R Age Gaz—Dec. 11, 1908. Serial. 1st part. No. 925.

England.

Railway Facilities in North-East Anglia. An explanation of the problem arising from the proposed amalgamation of the Great Northern, Great Central, and Great Eastern railways. 2000 w. Engr, Lond—Oct. 30, 1908. No. 198 A.

Presidential Address of James Charles Inglis, before the Institution of Civil Engineers. Discusses the question of transport, especially the work of Isambard Kingdom Brunel. 10000 w. Engng—Nov. 6, 1908. No. 325 A.

The London and North-Western Railway and Crewe Works. A review of the history and detailed description of the principal features. Plates and Ills. 21000 w. (Sup.) Engr, Lond—Dec. 11, 1908. No. 1221 A.

Government Ownership.

The Nationalization of Railways. C. S. Vesey Brown. Discusses the practical workings of state ownership in various countries. 3500 w. Cassier's Mag—Dec., 1908. No. 947 B.

Railway Nationalization. Sir George Gibb. Read at meeting of the Royal Economic Society, London. Discusses the various phases of this subject. 3500 w. R R Age Gaz—Dec. 4, 1908. Serial. 1st part. No. 806.

History.

The Centenary of Railroad Travel. W. B. Paley. Concerning Richard Trevithick's experiments, one-hundred years ago. 1000 w. R R Age Gaz—Nov. 6, 1908. No. 132.

Management.

Organization. A description of the organization of the motive power department of the Lake Shore & Michigan Southern Railway. An important study. 12500 w. Am Engr & R R Jour—Dec., 1908. No. 846 C.

Montenegro.

The First Railway in Montenegro (La Prima Ferrovia nel Montenegro). A. Baldacci. Describes the line and discusses its economic importance. Ills. 5000 w. Riv Marit—Oct., 1908. No. 537 E + F.

United States.

Southern Railroads and Their Needs. John F. Wallace. Extract from an address before the Southern Commercial Congress. 2500 w. Ry & Engng Rev—Dec. 19, 1908. No. 1063.

Review of 1908. Annual Reports. Ray Morris. Review by means of a graphic diagram with explanatory notes. 1500 w. R R Age Gaz—Dec. 25, 1908. No. 1289.

Valuation.

Railway Capital and Values. W. H. Williams. Extracts from a paper before the Traffic Club of New York. A study of methods of valuation and results in the state of Michigan. 1500 w. Ry & Engng Rev—Dec. 26, 1908. No. 1283.

STREET AND ELECTRIC RAILWAYS

Brakes.

Brakes for Electric Tram Cars. Edgar Harry Cockshott. Describes investigations carried out to ascertain the reliability of brakes in use under adverse conditions, and to devise, if possible, a new brake of greater efficiency. 5500 w. (Abridged.) Inst of Civ Engrs—No. 3752. No. 882 N.

Brooklyn.

The Line and Track Department Headquarters of the Brooklyn Rapid Transit System. I. General Features of Arrangement and Construction. The present article illustrates and describes architectural and constructional features. 3500 w. Elec Ry Jour—Dec. 5, 1908. Serial. 1st part. No. 799.

Canal Haulage.

Electric Canal Haulage (Der elektrische Schiffszug). Georg Meyer. An exhaustive discussion of the various systems. Ills. 13000 w. Elek Kraft u Bahnen—Nov. 14, 1908. No. 1178 D.

Cars.

New Standard Car for the Metropolitan Street Railway, New York. An account of investigations made to determine the

We supply copies of these articles. See page 904.

best type to meet conditions, with illustrated description of the car adopted and its equipment. 2500 w. Elec Ry Jour—Dec. 5, 1908. No. 800.

The Barber Single-Truck Car Used on the Sunbury and Salingsgrove Electric Railway. Illustrated detailed description. 1500 w. Elec Ry Jour—Jan. 2, 1909. No. 1436.

Double Motor Cars on the Blankenese-Ohlsdorf Railway (Automotrices couplées du Chemin de Fer électrique de Blankenese à Ohlsdorf par Hambourg). A. Le Vergnier. Illustrated description of a double car with two motors. Plate. 1500 w. Génie Civil—Nov. 7, 1908. No. 1119 D.

Communication.

The Installation and Protection of Telephones for Electric Railway Service. Frank F. Fowle. Illustrated detailed description, with information in regard to types, cost, etc. 4000 w. Elec Ry Jour—Dec. 5, 1908. No. 801.

Economics.

Action Necessary to Assure a Reasonable Return on the Investment. Charles V. Weston. Discusses the present situation, reviewing the development of transportation in city streets and related matters. 4500 w. Elec Ry Jour—Dec. 26, 1908. Serial. 1st part. No. 1252.

France.

Electric Traction on the Fayet-Chamonix Line and Its Extension to the Swiss Frontier (La Traction electrique sur la Ligne du Fayet à Chamonix et à la Frontière Suisse). M. Auvert. Illustrated description of the power plants, transmission line, substations, rolling stock, etc., of this direct-current road in France. Plates. 5000 w. Rev Gen d Chemins de Fer—Nov., 1908. No. 1112 G.

Interurban.

The Brantford and Hamilton Electric Railway. Illustrated description of a line in Ontario eventually to form part of a system joining Toronto and Detroit. 2000 w. Elec Ry Jour—Jan. 2, 1909. No. 1434.

Locomotives.

Change in Wheel Arrangement of New Haven Electric Locomotives. Drawing and brief description. 300 w. R R Age Gaz—Dec. 4, 1908. No. 804.

Massachusetts.

Financial Condition of Massachusetts Street Railways. James L. Richards. Abstract of an address before the Mass. St. Ry. Assn. 5000 w. Elec Ry Jour—Dec. 19, 1908. No. 1045.

Rack Railways.

A New Mountain Railway in Tyrol. Brief illustrated description of the Rittner line, a portion of which is a rack on the Strub system. 1800 w. Elec Engng—Dec. 10, 1908. No. 1205 A.

Railless.

General Urban and Interurban Transportation and Railless Electric Traction. F. Douglas Fox. Read at Dublin meeting of the British Assn. Aims to show in detail the comparative economics of the tramway and the mechanical omnibus. 4200 w. Engr, Lond—Nov. 20, 1908. No. 746 A.

Single Phase.

Some Notes on the Single-Phase Railway System. Clarence Renshaw. Considers the equipment and operation of single-phase installations. Ills. 6000 w Elec Jour—Dec., 1908. No. 976.

Subways.

Accounts of the London Tube Railways. A detailed analysis for the year ending June 30, 1908. 2500 w. Elect'n, Lond—Dec. 11, 1908. No. 1209 A.

Switzerland.

The Railway of the Bernese Alps (Visite aux Travaux du Chemin de Fer des Alpes Bernoises). A. Maury. Report of a visit by a committee of the Soc. Ing. Civ. de France. Brief description of the line and of the Loetschberg tunnel. 10000 w. Mem Soc Ing Civ de France—Oct., 1908. No. 1307 G.

Track Circuits.

Suburban Electric Railway Return Circuits. E. G. Hindert. Discusses the importance of good contact, types of bonds, testing, etc. 3000 w. Elec Age—Dec., 1908. No. 1229.

Track Construction.

Track Reconstruction in New York. A report of improvements made during 1908, describing construction and methods. 1800 w. Elec Ry Jour—Dec. 26, 1908. No. 1253.

Wires.

Tensile Strength of Trolley Wires. J. E. Fries. Information concerning metals that might be used, and concerning the stringing of such wires. 2000 w. Elec Age—Dec., 1908. No. 1228.

Wire Suspension.

Cost and Construction of Overhead Work. E. Golding. Presents a table of costs to facilitate the estimating for overhead work, with explanatory notes. 1500 w. Elec Rev, Lond—Nov. 20, 1908. No. 732 A.

Experimental Overhead Trolley Construction of the Pennsylvania Tunnel and Terminal Railroad. An illustrated account of this expensive experimental work on the test line on Long Island. Also editorial. 6500 w. Elec Ry Jour—Dec. 12, 1908. No. 918.

See also Wires, under STREET AND ELECTRIC RAILWAYS.

We supply copies of these articles. See page 904.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

SPECIAL NOTICE.—To avoid the inconvenience of letter-writing and small remittances, especially from foreign countries, and to cheapen the cost of articles to those who order frequently, we sell coupons at the following prices:—20 cts. each or a book of twelve for $2.00; three books for $5.00.

Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents; thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

Write for a sample coupon—free to any part of the world.

CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cents per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated: W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.

Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *w.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *m.* Milan.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *b-m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Age Gazette. *w.* New York.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Signal Engineer. *m.* Chicago.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Surveyor. *w.* London.
Technology Quarterly. *qr.* Boston, U. S. A.
Technik und Wirtschaft. *m.* Berlin.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Building Construction.

Safe Building Construction. By Louis de Coppet Bergh. Size, 7¾ by 5 in. Ills. Price, $5. New York: The Macmillan Company.

A new edition of a work first published over twenty years ago. It is intended to be a treatise giving in simplest forms possible practical and theoretical rules and formulæ used in construction of buildings. The book takes up the strength of materials, foundations, cellar and retaining walls, arches, floor beams and girders, analysis of transverse strains, reinforced concrete construction, rivets and riveting, plate and box girders, analysis of strains in trusses, trusses of wood and iron, and columns. It has long been a standard book of reference on applied mechanics for architectural draftsmen. The treatment is simple, the book contains many useful and novel practical notes and formulæ, but its constant betrayal of the fact that it was written in the early eighties of the last century will hardly recommend it to the present-day engineer.

Electrical Engineering.

The Arithmetic of Electrical Engineering. Size, 7¼ by 5 in.; pp., 159. Ills. Price, 50 cents. New York: The Macmillan Company; London: Whittaker & Co.

The aim of this little book is to aid the electrical engineering student in acquiring the ability to calculate quickly and accurately. The plan adopted recognizes the difficulty young students encounter in applying their theoretical knowledge to practical problems. The fundamental quantitative relationships and laws related to the special subject under consideration are given briefly at the head of each chapter and then numerous worked-out typical examples illustrating the principles of the subject. These are followed by problems for the student's own working. In all there are 72 examples fully worked and 300 problems for the student. The book should be of assistance not only to students in elementary classes, but also to teachers who have occasion to set problems.

Engineering Calculations.

Practical Calculations for Engineers. By C. E. Larard and H. A. Golding. Size, 7½ by 5¼ in.; pp., 455. Price, $2. Philadelphia: J. B. Lippincott Company; London: Charles Griffin and Company, Limited.

A practical manual dealing with calculations and graphical methods applied to engineering. The general aim of the authors in preparing the work has been to familiarize the student with modern methods of making rapid calculations by the calculating slide rule; some of the more important engineering problems which have to be solved in experimental work, in the workshops, in the drawing office and by the management; graphical methods for the ready interpretation of the results of experimental and commercial work; and the importance of making a study of the business side of his profession. The contents include chapters on technical mensuration; calculation by common logarithms; mechanical calculating devices; pulley problems; principles of moments; work, power and energy; transmission of work through machines; transmission of power; centrifugal force and balancing; acceleration and momentum; steam boiler problems; engine calculations; the commercial side of engineering; the calculation of weights; estimating and cost distribution; remuneration of labor; and the use of section paper in engineering work.

Engineering Reminiscences.

Engineering Reminiscences. By Charles T. Porter. Size, 9 by 6 in.; pp., 335. Ills. Price, $3, 12/6. New York: John Wiley & Sons; London: Chapman & Hall, Limited.

A reprint of series of articles contributed to the columns of *Power* and the *American Machinist*. The venerable author, who is now over 80 years of age, was a pioneer in the design and introduc-

tion of the high-speed steam engine in America, and his reminiscences are not only an autobiography but a history of the development of the type of prime mover to the study of which he devoted so many years of his life. The book is written in entertaining style and, quite apart from its value as engineering history, the interest attaching to its frank recital of successes and failures will well repay perusal.

Gas Engineering.

Handbook of American Gas Engineering Practice. By M. Nisbet-Latta. Size, 8½ by 6 in.; pp., 466. Ills. Price, $4.50. New York: D. Van Nostrand Company.

This work is divided into three parts. The first discusses the practical details of water-gas manufacture from the fuels and materials to the gas holder. The second division is devoted to gas distribution, which is treated at length and in a practical manner, and to a brief consideration of the various gas burning appliances. The final part contains a great deal of theoretical, mathematical and technical information on the properties of gases and steam, calorific values, temperature data, testing corrections, tables, etc. The book is a valuable addition to the literature of gas engineering.

Hydro-Electric Plants.

Development and Electrical Distribution of Water Power. By Lamar Lyndon. Size, 9 by 6 in.; pp., 317. Ills., 158. Price, $3, 12/6. New York: John Wiley & Sons; London: Chapman & Hall, Ltd.

The author disclaims any intention of writing a text-book on electricity, hydraulics, concrete work or construction engineering. His aim has been to produce a purely engineering treatise in which all the salient facts concerning the hydraulic development of power, its conversion into electrical energy, and its transmission over long distances, are collated, and their interdependence shown. For the basic principles of hydraulics and electricity the reader is referred to works on these special subjects. The author is concerned only with the relationships between the available power, methods of development, the machinery and apparatus employed, and the final use to which the energy will be put. Part I, on hydraulic development, discusses in separate chapters general conditions, dams, canals and flumes, design of hydro-electric power houses, and water wheels. Part II deals similarly with electrical equipment, devoting chapters to general considerations, alternators, transformers, transmission conductors, pole line and accessories, lightning protection, and switching and control apparatus, and an appendix to the computation of pressures set up in long pipe lines with change in gate opening. The final chapters of the book are devoted to descriptions of nine typical hydro-electric developments in Europe and America.

Power Transmission.

Power and Power Transmission. By E. W. Kerr. Size, 9 by 6 in.; pp., 366. Ills. Price, $2, 8/6. New York: John Wiley & Sons; London, Chapman & Hall.

A book for the beginner in the study of mechanical engineering, largely based on lectures delivered by the author on the elementary principles of engineering. The three parts deal, respectively, with machinery and mechanics, steam power, and pumps, gas engines, water power, compressed air, etc. None of the subjects is treated exhaustively; the aim has been merely to present guiding principles for more thorough investigation. The volume in hand is a second and revised edition. The chapters on steam turbines and valve diagrams have been rewritten and several pages of matter have been added on the subject of heat and the use of steam tables. The value of the book has been further increased by the addition of a large number of good problems and a thorough correction of the errors appearing in the former edition.

Sewage Treatment.

Methods and Devices for the Bacterial Treatment of Sewage. By William Mayo Venable. Size, 9 by 6 in.; pp., 236. Ills., 43. Price, $3, 12/6. New York: John Wiley & Sons; London: Chapman & Hall, Limited.

A discussion of bacterial sewage purification from the standpoint of the civil engineer. The book opens with a brief introductory chapter on the general aspects of sewage purification, followed by a bibliography of books and articles in technical magazines on sewage disposal and related subjects, including the bacterial and chemical analyses of polluted waters. The several methods of sewage treatment are next considered in historical order, separate chapters being devoted to the aerobic treatment of sewage, mechanical removal of sludge, anaerobic treatment of sewage, intermittent contact systems, automatic discharging devices and percolating filters. A summary is then given of the engineering principles involved in the design of purification works, difficulties experienced in some actual installations are described, and the final chapter illustrates the application of the principles enunciated by the author to a few typical examples.

Steel Analysis.

Steel Works Analysis. By John Oliver Arnold and F. Ibbotson. Size 7½ by 5 in.; pp., xiv, 468. Ills. Price, $3.50, 10/6. New York: The Macmillan Company; London: Whittaker & Co.

A third edition of this well known work, thoroughly revised and considerably enlarged. The general scheme remains unaltered but descriptions of a number of operations now obsolete, included in previous editions, have been omitted, and outlines of new and more rapid methods have been substituted. The most important change, however, is the inclusion of a large amount of new matter on the determination of the elements which have only recently been utilized in the making of steel, the analysis of their ores, of alloy steels, and of ferro-alloys. The section on gas analysis has been thoroughly revised and brought up to date and the latest developments in the calorimetry of fuels are described. Chapters on the analysis of bearing metals and of high-speed steels are other new features. The book will retain its reputation as a clear, thorough and practical guide for the steel-works chemist.

Technical Dictionaries.

Technological Dictionary in French, German and English. Edited by Alexander Tolhausen. Revised by Louis Tolhausen. In three volumes: Volume I, French - German - English; Volume II, English - German - French; Volume III, German - English - French. Size, 6¾ by 4¾ in.; pp., Volume I, 1006; Volume II, 1026; Volume III, 1025. Price, each volume, $2.75. New York: The Macmillan Company.

This well known work, which was published first in 1877, has now reached its fifth edition. It is issued in the form which has been familiar to the engineers of over a generation, but its contents have been considerably improved by a thorough revision of the text and by the addition of a large supplement including all modern terms and expressions in electricity, telegraphy and telephony. The work is wider in scope than most of the smaller technical dictionaries on the market. It is not devoted solely to engineering as that term is now understood, but includes in its plan the definition of terms relating to a large number of the arts, to pure science, and to business. The breadth of its field is at once its greatest defect and its greatest recommendation. As an engineering dictionary it will hardly satisfy the requirements of the modern engineer, but he will find in it a valuable supplement to other works, on account of its inclusion of subjects related to, but not directly connected with, engineering proper.

Illustrated Technical Dictionary in Six Languages: English, German, French, Russian, Italian and Spanish. Edited by K. Deinhardt and A. Schlomann. Volume III, Steam Boilers, Steam Engines, Steam Turbines; Volume IV, Internal-Combustion Engines. Size, 7 by 4 in.; pp., Volume III, 1322; Volume IV, 618. Price, Volume III, $4; Volume IV, $3. New York: McGraw Publishing Co.

We have already had occasion to mention very favorably the two preceding volumes of this dictionary, dealing, respectively, with machine details and tools, and electrical engineering. The two present volumes are fully up to the high standard of those which have already appeared. Thoroughness and painstaking accuracy on the part of the compilers and editors are apparent throughout, and we believe that the successful accomplishment of so much of the immense undertaking gives abundant assurance that the complete work, for which eleven volumes are projected, will stand pre-eminent for completeness and trustworthiness among technical dictionaries in the special fields it is designed to cover.

Water Powers.

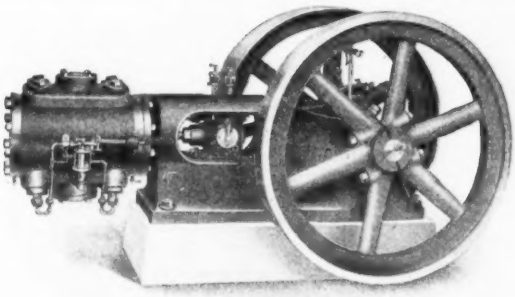
Water Power Engineering. By Daniel W. Mead. Size, 9 by 6 in.; pp., 787. Ills., 413. Price, $6. New York: McGraw Publishing Company.

A treatise on the theory, investigation and development of water powers. The author had endeavored to consider all fundamental principles in the investigation, design and execution of water-power development projects and to point out the economic basis on which successful power development depends. The first three chapters are devoted to a general discussion of the history and general principles of hydraulic engineering. Chapters IV to XI deal with the study of water-power projects, rainfall, run-off and stream flow and its measurement. Water wheels and turbines, their selection, testing, governing, arrangement, etc., are treated at length in Chapters XII to XX. The design of plant is then discussed, chapters being devoted to the selection of machinery, the relation of dam and power station, the design of dams, appendages to dams, pondage and storage, etc. The two closing chapters are devoted to the economics of water-power projects.

THE CURRENT RECORD OF
IMPROVED MACHINERY
NEW METHODS NEW MATERIALS
NEW APPLIANCES

The New Dallett Air Compressors.

IT gives us much pleasure to announce to our readers the entry into the air-compressor field of the firm of Thomas H. Dallett Co., Philadelphia, Pa., the well-known manufacturers of pneumatic tools. The new compressors which this firm has recently placed on the market represent the latest and most up-to-date ideas in compressor construction. The standard line includes steam and belt-driven machines in sizes from 8 inch to 16 inch stroke, ranging in capacity from 79 cubic feet to 1,200 cubic feet of free air per minute, but the Company is prepared to build special machines for any capacity, pressure or service, or to supply standard machines direct-connected to electric motor, water wheel or gas engine. The illustration shown on this page represents the standard type of belt-driven machine.



Among the more important of the many excellent features claimed for these compressors may be mentioned the provision made for rigidity in operation. This is obtained by the use of a liberal amount of metal, scientifically placed, in the construction of the machines. The frame is of the open-fork, center-crank type, of an especially massive and rigid design. On account of the liberal provision made for stability it is possible to obtain on compressors of each of the standard sizes a greater range of capacity by the substitution, when desired, of a cylinder of the next larger size than the standard. For example: On an 8 inch stroke machine the regular cylinder for a maximum air pressure of 100 pounds is 8 inches in diameter, but the compressor will still deliver air at this

pressure if a cylinder 10 inches in diameter be substituted for the smaller size. In this way, a greater volume of air is

obtained at only a slight increase in the cost of the machine.

Ample provision has been made for efficient governing of these compressors. On the steam machines a combined speed and pressure governor is used, which unloads the air cylinder exactly the same as on a belt-driven machine, and at the same time controls the speed, allowing a single steam machine to just turn over when unloaded, and bringing a duplex or compound machine to a dead stop.

By this means a great saving in steam is effected and the wear and tear on the working parts, as in the case of continuous running machines, is reduced. On every belt-driven machine the governor is equipped with a safety stop device, which immediately stops the machine in the event of the breaking of the governor belt. On the single steam machine the governor pulley is situated on the end of the shaft outside of the fly wheel, thus bringing the fly wheel as close to the bearing as possible, in accordance with the best construction, and also eliminating the possibility of oil or grease from the eccentric getting on the governor belt.

A difficulty with duplex compressors with compound steam cylinders has been that if the machine stops with the high-pressure side on the dead center it will not start automatically, because only the high-pressure cylinder receives steam from the line. Means have been incorporated in the design of the Dallett compressors for overcoming this trouble. In case the high-pressure side stops on the dead center, steam enough to start the compressor can be admitted into the low-pressure cylinder through a pressure-reducing valve of standard make used only for this purpose. Steam from the boiler, of course, is taken in to the low-pressure side only when starting from the dead center; at other times the operation is identical with any compound machine.

One of the departures from ordinary practice in designing the various parts of the compressor is to be found in the cross-head, which is of a new type, box pattern, made of semi-steel. Its shoes

are adjustable and are of large bearing surface. The upper shoe is lubricated by means of a sight-feed lubricator, and the lower shoe runs continually in a bath of oil. One of the novel features of this cross-head is the side openings, which allow easy access to the cross-head shoe-binder bolts.

The intake valve is of the automatic poppet type, carried in a malleable-iron cage. The cage is in one piece and

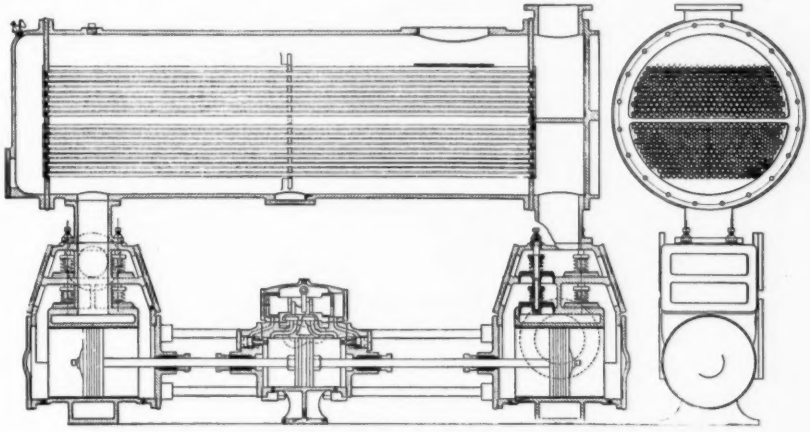
combines both the seat for the valve and the guide for the valve stem. The cage is threaded and screws into the wall of the air intake chamber only; it is simply

seated in a recess on the main cylinder wall, thin, corrugated copper gaskets being used to secure a tight joint. A hexagonal recess has been cast in all cages to accommodate a special cast-steel wrench for use in removing and replacing valve cages. Certain makes of intake valves of the automatic poppet type are liable to give trouble on account of the shearing off or working loose of the spring-holder. The cause is due to the sudden stopping of the valve on the seat, which tends to drive the spring holder off the valve stem, on identically the same principle by which a hammer is driven on its handle by means of striking the opposite end of the latter. In the Dallett valve, an illustration of which is shown, the spring holder consists of a split taper ring set into a recess on the valve stem and held tight to the stem by means of a solid taper ring, which slips down over it. The result of the use of the taper is that the hammering of the valve on its seat tends to tighten the spring holder on the stem instead of driving it off.

Full details of the many important features of these new compressors, only a few of which are mentioned above, are given in an illustrated catalogue No. 100, recently issued by the makers, which they will be pleased to send to any one interested on request. Address Thomas H. Dallett Co., Philadelphia, Pa., U. S. A.

New Design of Surface Condenser.

THIS apparatus is especially recommended for locations where the water supply for condensation is salt or unfit for boiler feed, and where it is desired to save the condensed steam for that purpose. It will readily maintain a vacuum of 26 inches referred to a 30-inch barometer when supplied with sufficient cooling water. The cylindrical condenser is mounted on top of a direct-acting combined air and circulating pump, the three cylinders of which are in a straight line: the steam cylinder in the center and the air and water cylinders at each end. By this arrangement



a very smooth and steady running pump is ensured, as the regulating action of the water pump equalizes the irregular load on the air pump.

The water chamber of the condenser rests directly on top of the water cylin-

der and the circulating water passes upward from the water cylinder and through the lower bank of tubes, returning through the upper bank and out at the highest point of the water chamber. The arrangement is such that no air can lodge in the condenser tubes and impair their efficiency. Exhaust steam entering the top of the condenser near the circulating water outlet spreads along the entire length of the condenser before passing on its course down through the tubes where it is condensed and finds its way by gravity to the air pump as condensed water, air and non-condensible vapors.

The condenser shell, water chamber and covers are cast iron. The tubes are seamless drawn brass and are secured at each end into Muntz metal tube plates by means of brass screw glands packed with corset lace packing. The tubes are free to expand and contract but are held from getting out of place endwise by a shoulder in the screw glands. Where the tubes are long, they rest in a support plate placed midway in their length. In all cases they are relieved from any impact of incoming steam by a baffle plate placed opposite the exhaust steam inlet.

The steam cylinder is of the well known Cameron type with no outside valve gear, and makes a full stroke every time. The steam cylinder heads are removable without disconnecting any of the other parts. Both pump cylinders are brass lined and fitted with brass pistons arranged for fibrous packing. The piston rods are of Tobin bronze and separate at the steam piston. The valve system in both air and water cylinders is of the usual Cameron arrangement. By removing the cover at each end of the cylinder every valve is exposed to view. Each valve stem holds two valves with their springs one above the other so that by simply unscrewing one plug and pulling out the stem both are released. The air and water cylinders are in the most accessible position for inspection and repairs, and the air piston and valves are submerged at all times.

The A. S. Cameron Steam Pump Works are prepared to build all sizes of surface condensers up to 1,500 H. P., and can furnish condenser shells of sheet steel or copper where lightness is a factor; or pump ends of all brass if desired. Where there is not sufficient head room, the condenser may be placed alongside the pump, but in all cases it should be high enough for the condensed water to flow by gravity to the air pump.

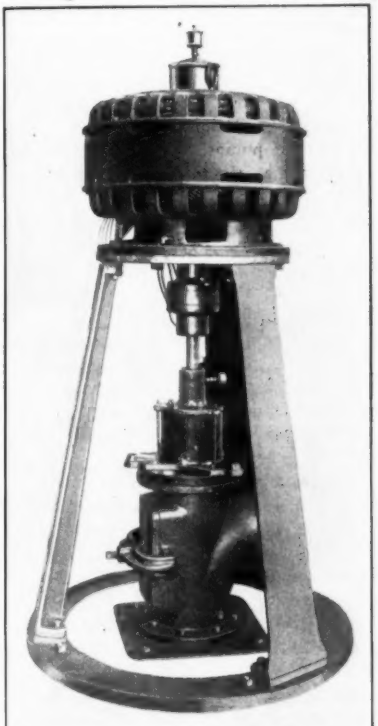
Rapid Switchboard Installation.

AN example of rapid telephone switchboard installation was given again by the Western Electric Company at Franklin, Pennsylvania, recently. A fire broke out in the building in which the exchange was located early in the morning of November 17th and in a few hours the city was without any convenient means of communication. Before the fire had burned itself out an order was wired to the Pittsburg house of the Western Electric Company to furnish as soon as possible the means by which Franklin might again have telephone service. A number of emergency boards, which Western Electric houses always have on hand, were set up in the city in about forty-eight hours after the fire, which supplied the needs of subscribers until a new switchboard was put in service. On the evening of the day the emergency boards were received from Pittsburg a car of switchboard material was received from the Western Electric manufacturing plant at Hawthorne, Illinois.

Impeller Pump for Condensing Service.

THE development of impeller pumps was made primarily for pumping water for irrigation purposes from deep wells, because of the simplicity of the parts in the well and the ability of this type of pump to handle all the water such a well will produce. The field of application has widened considerably since these pumps came into use until now there are installations in many classes of service. Shown herewith is a view of one of the 10-inch Columbus impeller pumps installed by Kingan & Company, one of the

largest pork packers in this country, in their plant at Indianapolis, Ind. There are three pumps, all alike, installed here; two pump water from deep wells into the reservoir, from which it is used for condensing purposes for a Westinghouse steam turbine of 500 K. W. capacity. A third of these pumps is installed to raise the water from the well to a higher storage reservoir, from which it flows by gravity throughout the plant. In each case the pump is equipped with a vertical Westinghouse induction motor of 75



horse power capacity and takes power from the two-phase alternating current system at 440 volts, supplied for the entire plant from the turbo-generator set and from several engine driven generators.

The principle on which the pump works suggests that of the centrifugal pump; but the "impellers," as they are called, are placed horizontally within the casing, as shown in the illustration, and are spaced about four feet apart along the shaft to which the motor is direct connected. The number of impellers depends upon the depth of the well. The lower two or three must be submerged at all times, that is, they must be below the lowest water level in the well. The water is whirled upward by the first impeller to a stationary vane located just beneath the second impeller. This vane, or "retarder," as it is called, stops the whirling motion of the water just before it enters the next impeller, but does not impede the upward progress. The second impeller then repeats the performance of the first and so on, till the water is discharged at the top.

The only wearing parts in the pump are the guide and thrust bearings, both of which are located at the top of the well, where they may be readily inspected and repaired when necessary. The thrust bearing is specially constructed with rollers, so that the friction is reduced, as it is rolling and not sliding friction. The vertical motor is thus not called upon to carry any weight but its own, but is coupled to the pump by a flexible coupling.

In a test recently made on the pump installed for pumping into the reservoir at the Kingan plant, the pump handled 1121 gallons of water per minute, with an average power consumption of 43.2 kilowatts, which means that the motor was running with an output of approximately 50 H. P., or at two-thirds load.

The pump is manufactured by the Roth Manufacturing Company, of Columbus, Indiana.

Industrial Notes.

—Henry Wallace Caldwell, founder and president of the H. W. Caldwell & Son Co., manufacturers of elevator buckets, Chicago, Ills., died on the 22d of December last at Redlands, Cal.

—The Southern branch of the American Steam Gauge & Valve Manufacturing Company, for several years located in the Equitable Building, Atlanta, Ga., has removed its office to 524-525 Candler Building, of that city.

—Wm. B. Scaife & Sons, Co., Pittsburgh, Pa., have received from Spang, Chalfant & Company, a contract for a large tonnage of structural steel work in connection with the extensive additions which are being made to their tube plant at Etna, Pa.

—Wm. B. Scaife & Sons Co., Pittsburgh, Pa., have received a contract from the Maryland Coal Company for a steel tipple and trestle to be erected at St. Michael, near Johnstown, Pa. The tipple will be one of the largest ever constructed in that part of the State.

—On December 31st last the old firm of Stanley G. Flagg & Co., Philadelphia, was dissolved and succeeded by Stanley G. Flagg, Jr., who now conducts the business under the same name as before. Stanley G. Flagg, Sr., withdraws from a long and successful business career.

—The business carried on by the American Engineering Specialty Co, with headquarters at Chicago, was taken over on January 1st, by Warren Webster & Co., Camden, N. J. This change will give to users and intending purchasers of Webster apparatus the full advantages of their organization, represented by twenty-two branch offices throughout the country.

—The American Engineering Specialty Co., heretofore representing the firm of Warren Webster & Co., in the Middle West, has been absorbed by the main company, and hereafter the twenty different agencies, in as many American cities, will be managed directly from the main office and works of Warren Webster & Co., at Camden, N. J. There is no change of personnel, and the same representatives will call upon the firm's clients.

—H. von Schon, consulting engineer, is preparing plans for a hydro-electric plant on the Sturgeon river in the Upper Peninsular of Michigan. The dam will be one hundred feet high, the water will be diverted in pipes and the output, some six thousand kilowatt, transmitted to the copper region near Houghton, Mich., for service in the mines. Material proposals include wooden stave and steel plate pipes, hydraulic and electric generating equipment and transmission line fixtures.

—Oscar E. Perrigo, M E., has established in Boston a correspondence school for instruction in modern cost system, office and shop system, shop management, etc., under the name of the Modern Systems Correspondence School, 6 Beacon Street. The plan of the school will be to give instruction in modern shop and factory cost systems, organization and management, shop betterment, etc., and will include instruction in modern methods of handling men, machinery and materials. Mr. Perrigo has had practical experience as shop superintendent and designer of machinery for some twenty years.

—The Buffalo Steam Pump Co., Buffalo, have contracted with the city of Grand Rapids, Mich., to furnish ten immense sewage pumps, having a total capacity under maximum conditions of over 250,000 gallons per minute. The pumps are to be placed in four stations, one station to contain two 18" pumps, the second to contain two 24" pumps, the third to contain two 24" pumps and the fourth station four 40" pumps; The Westinghouse Electric & Mfg. Co., furnishes the electrical equipment on a separate contract. The ten pumps together without motors will weigh approximately 200,000 lbs.

—In order to handle its increasing business to better advantage the Raymond Concrete Pile Company, of New York and Chicago, has recently established two new branch offices, one at 204 Perrin Building, New Orleans, and another at 620 Chestnut St., St. Louis. The New Orleans office is in charge of G. B. Raymond, one of the sons of the late A. A. Raymond, inventor of the pile that bears his name. Mr. Raymond will take care of all business for his company in the Southern States. The St. Louis office is in charge of Warren A. Tyrell, C. E., who has represented the Raymond Company in that city for some time.

Announcement is made of the consolidation of the American Blower Company, of Detroit and the Sirocco Engineering Company, of New York. The factories of the American Blower Company of Detroit and of the Sirocco Engineering Company at Troy, N. Y., will continue in operation, but under one management, the home office to be at Detroit, Michigan. James Inglis, President of the American Blower Company becomes president of the consolidated companies and William C. Redfield, president of the Sirocco Engineering Com-

pany becomes vice-president. Charles H. Gifford, until about a year ago general manager of the B. F. Sturtevant Company, is the treasurer.

—The Green Fuel Economizer Co., of Matteawan, N. Y., describe a new type of hot blast heater coil or radiator for indirect heating systems in a 16-page pamphlet. The novel feature of this heater is that the circulation of steam, air and condensation is positive and continuous, and in the natural direction of gravity drainage from inlet to outlet, whereas, in heaters employing a single header at the bottom the air and water must at times circulate either against the current of steam or else contrary to the force of gravity. Other advantages of this new heater are accessibility to each individual pipe for inspection, cleaning, or repair, without disturbing other pipes and the ability to circulate hot or cold water or brine, if desired. The several novel features of construction described and illustrated in this booklet will be of interest to engineers who are called upon to design, purchase, or install hot-blast heating and drying outfits or other similar work.

—An important contract for electrical machinery has just been closed by the Oxford Paper Company, of Rumford Falls, Me., with the Western Electric Company. The machinery purchased includes five motor-generator sets consisting of 5-500 H.P., 2,300 volt induction motors, driving 330 K.W., 230 volt, direct current generators, with motor driven exciters and a thirteen panel switchboard. Power is to be taken from the line of the Rumford Falls Power Company, which is increasing its plant for that purpose. Everything is of the most modern type and designed to include the latest improvements in apparatus of its class. This electrical machinery is to be used in a large new plant which the Oxford Paper Company is now building at its Rumford Falls mills to manufacture for its own use, bleach liquor and caustic soda by a new electrolytic process, invented by Jasper Whiting, of Boston, and developed under his direction during the past three years to a point where it is said to have obtained a high degree of efficiency. The Whiting process, unlike those previously used for manufacturing the above chemicals, employs mercury as an agent and produces only chemically pure materials. It is said to be exceptionally economical as regards the use of power and to require only a minimum amount of labor in its operation. A very great saving in the cost of manufacture of pulp and paper is expected to result from the installation of this plant.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Abrasive Wheels.

THE ABRASIVE MATERIALS COMPANY, Philadelphia, Pa.—Extensive catalogue of abrasive grinding wheels—principally emery and corundum. Many designs are shown, giving special wheels for a great variety of work. 6 by 9 in.; pp. 68.

Aermotor.

THE AERMOTOR CO., Chicago—Extensively illustrated catalogue showing widely differing types of aermotors and their application. It is prefaced by a very interesting historical sketch of the wind-mill or motor. 4½ by 8 in.; pp. 64.

Air Compressor.

A new catalogue illustrating and describing in detail the new "Dallett" air compressor, which has just been put upon the market by the firm of Thomas H. Dallett Co., Philadelphia, Pa. Many points of improvement and excellence are claimed for this new compressor, and hence the pamphlet will be instructive and valuable to engineers who are interested. 9 by 12 in.; pp. 24.

Air Washer.

An illustrated folder describing the new air washer and humidifying apparatus which the firm of Warren Webster & Co., of Camden, N. J., has introduced as the result of extensive, costly, and notably successful experiments, particularly in large factory buildings, hotels and department stores.

Boilers.

LYONS BOILER WORKS, Monadnock Block, Chicago, Ill.—An interesting pamphlet describing the plant of the Lyons Boiler Works and showing progress in the shops. 9 by 6 in.

Bolsters.

SIMPLEX RAILWAY APPLIANCE CO., First National Bank Bldg., Chicago, Ill.—General cata-

logue of Simplex truck bolsters of several patterns. 9 by 6 in.; pp. 22.

Brazing Process.

REINFORCED BRAZING AND MACHINE CO., Pittsburg, Pa.—Catalogue with excellent illustrations showing broken cast-iron members repaired by brazing. 9 by 12 in.

Chucks.

THE HODGSON & PETTIS MFG. CO., New Haven, Conn.—Catalogue briefly illustrating in detail the Sweetland series of lathe chucks. 4½ by 7 in.; pp. 54.

Concrete Mixers.

FOOTE MANUFACTURING CO., 184 La Salle St., Chicago, Ill.—Two-color catalogue illustrating in detail the Foote concrete mixer in five sizes and fifty different equipments adapted for all classes of concrete work. 9½ by 6½ in.; pp. 72.

THE INTERNATIONAL F. AND FIREPROOFING CO., Columbus, O.—Briefly illustrated catalogue of the American concrete mixer. 7 by 5 in.; pp. 16.

Crushers and Pulverizers.

THE WILLIAMS PATENT CRUSHER AND PULVERIZER CO., 545 Old Colony Bldg., Chicago, Ill.—Extensive illustrated description of the Williams patent crusher and pulverizers, giving sizes, applications and uses. 6 by 9 in.; pp. 58.

Engines, Automatic.

ERIE MANUFACTURING AND SUPPLY CO., Erie, Pa.—Handsome descriptive catalogue of the Erico automatic engines, Hardwich feed-water heaters and Riblet feed-water heaters. 9 by 6 in.; pp. 24.

Gas Engines.

THE ELYRIA GAS ENGINE CO., Elyria, Ohio.—Descriptive catalogue of the Elyria high-duty gas engine. 9 by 6 in.

Gears.

BOSTON GEAR WORKS, Norfolk Downs, Mass.—Pocket size catalogue showing steel spur, bevel, miter and helical gears. Contains many valuable reference tables. 3½ by 6 in.; pp. 94.

Hoisting Machinery.

PARKER HOIST & MACHINE CO., 971-2 North Francisco Ave., Chicago, Ill.—Pocket size catalogue illustrating and describing the Parker hoisting engine and its parts and several forms of cranes and derricks. 5 by 7 in.; pp. 126.

Injectors.

THE OHIO INJECTOR COMPANY, Wadsworth, Ohio—A comprehensive catalogue of the Ohio mercantile injector and the Garfield injector and ejector and the Chicago sight-feed lubricator. 6 by 9 in.; pp. 72.

Locomotives.

A series of bulletins illustrating many types of electric locomotives for varied industrial service. 9 by 7 in.

Metallic Packings.

THE UNITED STATES METALLIC PACKING CO., 429 North 13th St., Philadelphia, Pa.—Brief catalogue of metallic packing for locomotive piston rods and valve stems. 4½ by 7 in.; pp. 24.

Mine Cars.

THE ATLAS CAR & MANUFACTURING CO., Cleveland, Ohio—Extensive catalogue showing many types of cars adapted for mining, plantation and industrial uses. 9 by 6 in.; pp. 80.

Oil Filters.

THE BURT MANUFACTURING CO., Akron, Ohio—An elaborate catalogue of Burt filters, exhaust heads and ventilators, including an extensive list of users in all parts of the world. 6 by 9 in.; pp. 96.

Pipe Cutting and Threading Machinery.

THE CURTIS & CURTIS CO., Bridgeport, Conn.—Illustrated catalogue of the Forbes patent die stock and pipe cutting and threading machinery for hand or power. 7½ by 10 in.; pp. 38.

Pneumatic Tools.

INDEPENDENT PNEUMATIC TOOL CO., First National Bank Building, Chicago, Ill.—Comprehensive catalogue showing the types, sizes and applications of the Thor system of pneumatic tools, together with an extensive list of parts, weights and dimensions. 6 by 9 in.; pp. 80.

Prospecting Drills.

NEW YORK ENGINEERING CO., 2 Rector St., New York—Complete catalogue of the Empire hand prospecting drills, containing many interesting illustrations of the drill in actual operation in various parts of the world. 6 by 9 in.; pp. 28.

Pumping Machinery.

FRED. M. PRESCOTT STEAM PUMP CO., Milwaukee, Wis.—A very handsomely arranged catalogue showing many types of pumping engines, steam pumps and condensing apparatus, covering mine pumps, boiler feeds, fire and general service and water-works pumping machinery. 6 by 9 in.; pp. 146.

Reamers.

THE CLEVELAND TWIST DRILL CO., Cleveland, Ohio—Pamphlet showing many styles and sizes of reamers, sockets, counterbores, mills, mandrels, arbors and high-speed tools. 6 by 9 in.; pp. 16.

Reinforced Concrete.

THE GABRIEL CONCRETE REINFORCEMENT CO., 1210 Penobscot Building, Detroit, Mich.—An exhaustive series of designing tables covering reinforced concrete construction, with special reference to the Gabriel concrete trussed bar. 9 by 6 in.; pp. 118.

Steam Specialties.

SHERWOOD MANUFACTURING CO., Buffalo, N. Y.—Comprehensive catalogue of engine and boiler supplies, with many illustrations and tables of sizes and capacities. 6 by 9 in.; pp. 72.

STRONG, CARLISLE & HAMMOND CO., Cleveland, Ohio—Illustrated description of open heaters, controllers, pump governors, boiler-feed regulators, traps and valves. 6 by 9 in.; pp. 44.